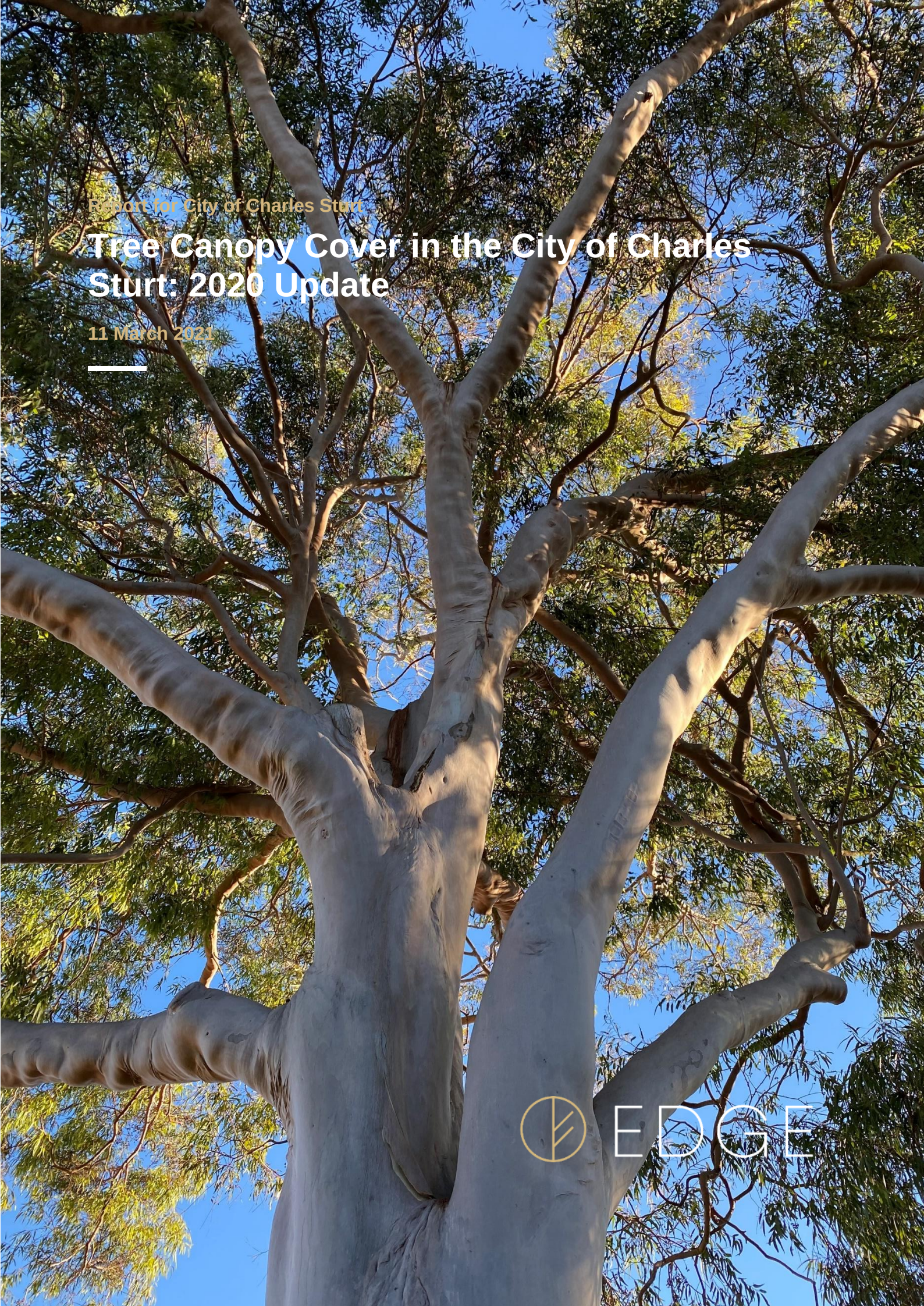

Report for City of Charles Sturt

Tree Canopy Cover in the City of Charles Sturt: 2020 Update

11 March 2021

EDGE

Project Delivered for:

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Revision	Revision Details	Author	Approved by	Date Approved
V1.0	Draft	Jenni Garden	Jenni Garden	05/12/20
V2.0	Final	Jenni Garden	Jenni Garden	11/03/21

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1 Key Findings

Whilst broad land cover trends remained consistent with the 2016 report, the key findings from this analysis are indicative of ongoing City-wide urban infill. Specifically, significant increases in impervious cover with decreases in tree canopy and plantable space cover, especially on private land. For example, as was noted in the 2016 report, it was still evident that tree canopy loss on private land is still outpacing gains on public land (Figure 1). This means that Council's ongoing tree planting efforts on public land are currently failing to stem the loss of canopy cover across the City.

St Clair also continues to be an anomaly amid general suburb-level land cover change trends as the suburb-wide conversion from the race-course to residential developments continues. The anomaly being that on public and private land, both tree canopy and impervious cover are increasing, with plantable space decreasing. Compared to the findings in the 2016 report, the trend in St Clair is now for the conversion of potential plantable space to a mixture of built, tree canopy, and grass cover. This trend is expected to continue for at least the next 3-5years as the residential development is completed. Following completion of the development works it is anticipated that the increase in impervious cover will slow for at least the following 10 years whilst the increase in tree canopy will increase as newly planted trees grow and mature across the suburb.

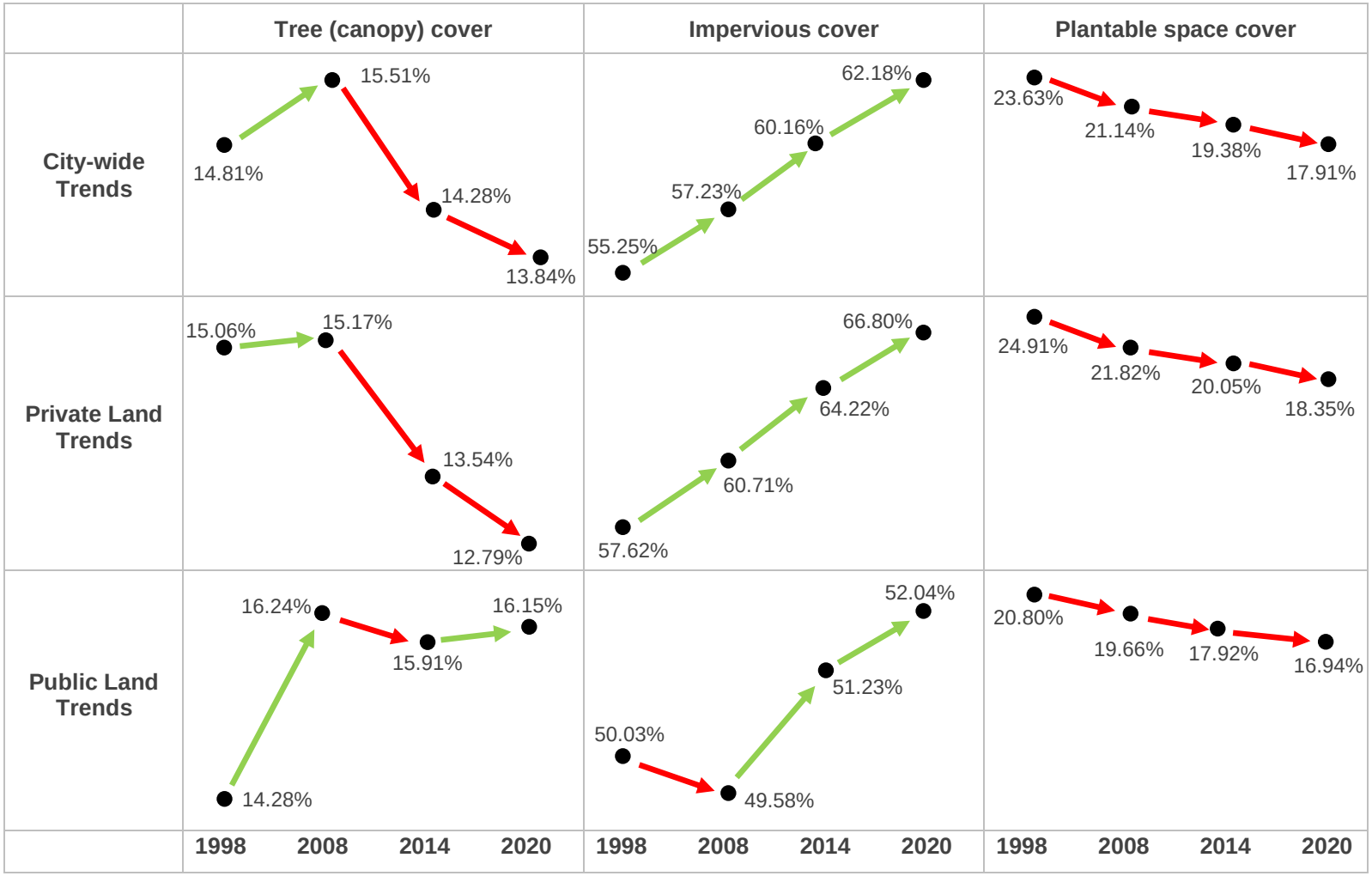

Figure 1. Comparison of high-level land cover change trends across the City as a whole and on private and public land, between 1998, 2008, 2014, and 2020. Values shown indicate the percentage of the tenure type comprised by the land cover type.

2 Context and Method

The following provides the findings from the 2020 land cover analysis which was conducted as an update to the benchmark and change over time analyses presented in the 2016 benchmark landcover report (Annex A). The same approach and method as detailed in the 2016 report was used for the 2020 analyses, and the same consultant conducted all analyses[1]. As such, this report should be read in conjunction with the 2016 report for a complete understanding of the background and context. Providing this update using the same approach as the 2016 analysis provides consistency across years and allows for direct comparisons of results. Aerial imagery from February 2020 was used to assess "current" (i.e. 2020) land cover across the city and in each suburb. Change in land cover over time was assessed between 2020 and historical years presented in the 2016 benchmark report. Aerial imagery was provided by Council for the purposes of these analyses.

3 Results

3.1 City of Charles Sturt

The following section provides the landcover results at a City-wide scale, including all public and private land tenures.

3.1.1 Land cover change trends to 2020

In 2020, the relative composition trend of land cover types remained that same; that is, like in previous analysed years, impervious land cover still dominated the City area, followed by potential plantable space, tree canopy, and other cover (Figure 2). Despite the composition trend being unchanged, the actual percentages of each land cover type had changed.

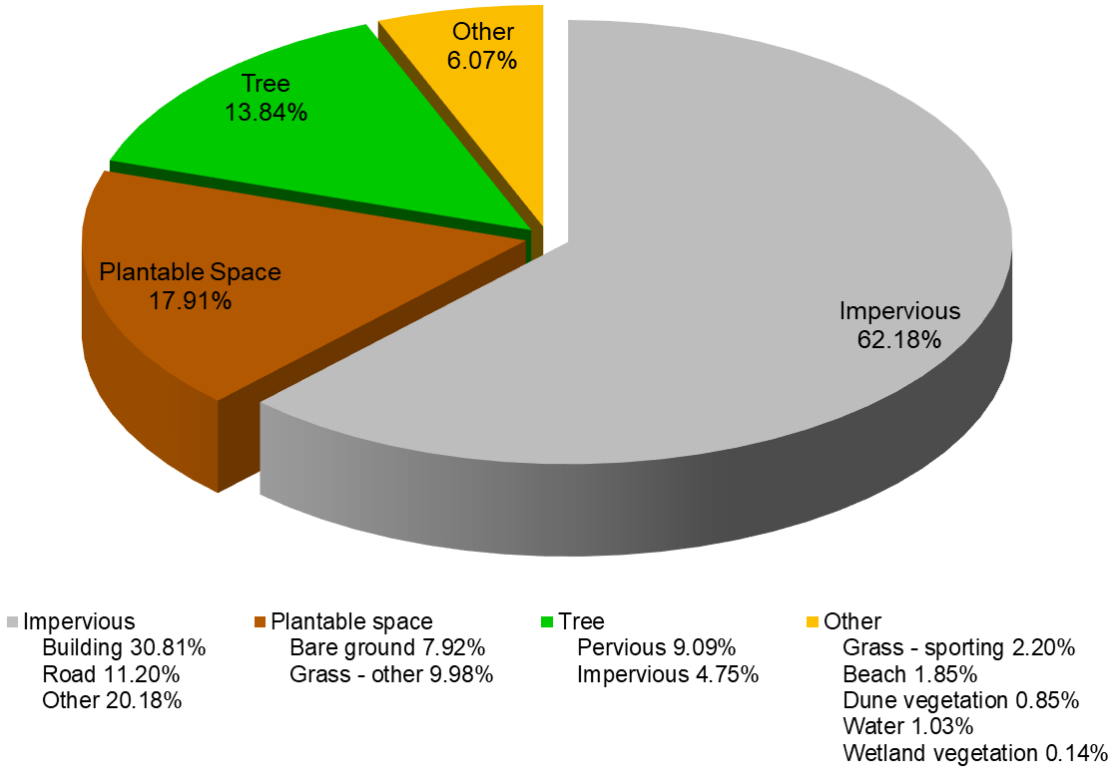

Figure 2. Estimated land cover across the City of Charles Sturt in 2020.

[1] Note that Seed Consulting Services (authored the 2016 report) merged with Edge Environment in late 2019

Impervious land cover comprised 62.18% of the City in 2020 (Figure 2), which was a highly significant increase of 2.02% since 2014 ($p<0.001$)[2] (Figure 3). At 30.81% of the City area, buildings comprised almost half of the impervious surfaces (Figure 2) and had increased significantly from 29.32% in 2014 and 26.24% in 1998 ($p=0.003$ and $p<0.001$, respectively) (Figure 3). The ongoing increase in building cover is likely due to ongoing urban infill and is the main driver of the increase in impervious cover, followed by an increase (not statistically significant[3]) in road and other cover.

Tree canopy cover comprised 13.84% of the City in 2020 (Figure 2) representing a loss of 0.44% since 2014. Whilst this city-wide loss over six years was not statistically significant, the 1.67% loss of tree cover over the last 12 years from 2008 was highly significant ($p<0.001$) (Figure 3). Again, this loss of canopy cover is considered to be likely driven by the ongoing urban infill across the City (Plate 1).

Plate 1. Example of urban infill resulting in tree canopy loss in Findon between 2014 (left) and 2020 (right).

Plantable space cover comprised 17.91% of the City in 2020 (Figure 2), which is a highly significant loss of 1.47% since 2014 ($p<0.001$). This was due to significant decreases in both bare ground and grass cover ($p=0.034$ and $p=0.012$). Observations during the analysis process suggests that this loss of plantable space is primarily due to replacement of previously plantable space by built impervious surfaces as part of the urban infill process (Plate 2), though may also be due to other land use changes, such as plantings and landscaping being established, and even tree crowns increasing in size and covering previously uncovered plantable space.

Other land cover refers to grassed sporting areas, beach, dune vegetation, water, and wetland vegetation, which together comprised the remaining 6.07% of land within the City in 2020 (Figure 2). The land cover type has remained relatively consistent across the years since 1998, with small changes considered to be due to fluctuations in water levels and associated wetland vegetation (Figure 3).

[2] Differences were considered statistically significant if p-values were less than or equal to the 0.05 critical alpha level

[3] Note that changes that are not statistically significant may still be practically significant for management and health purposes.

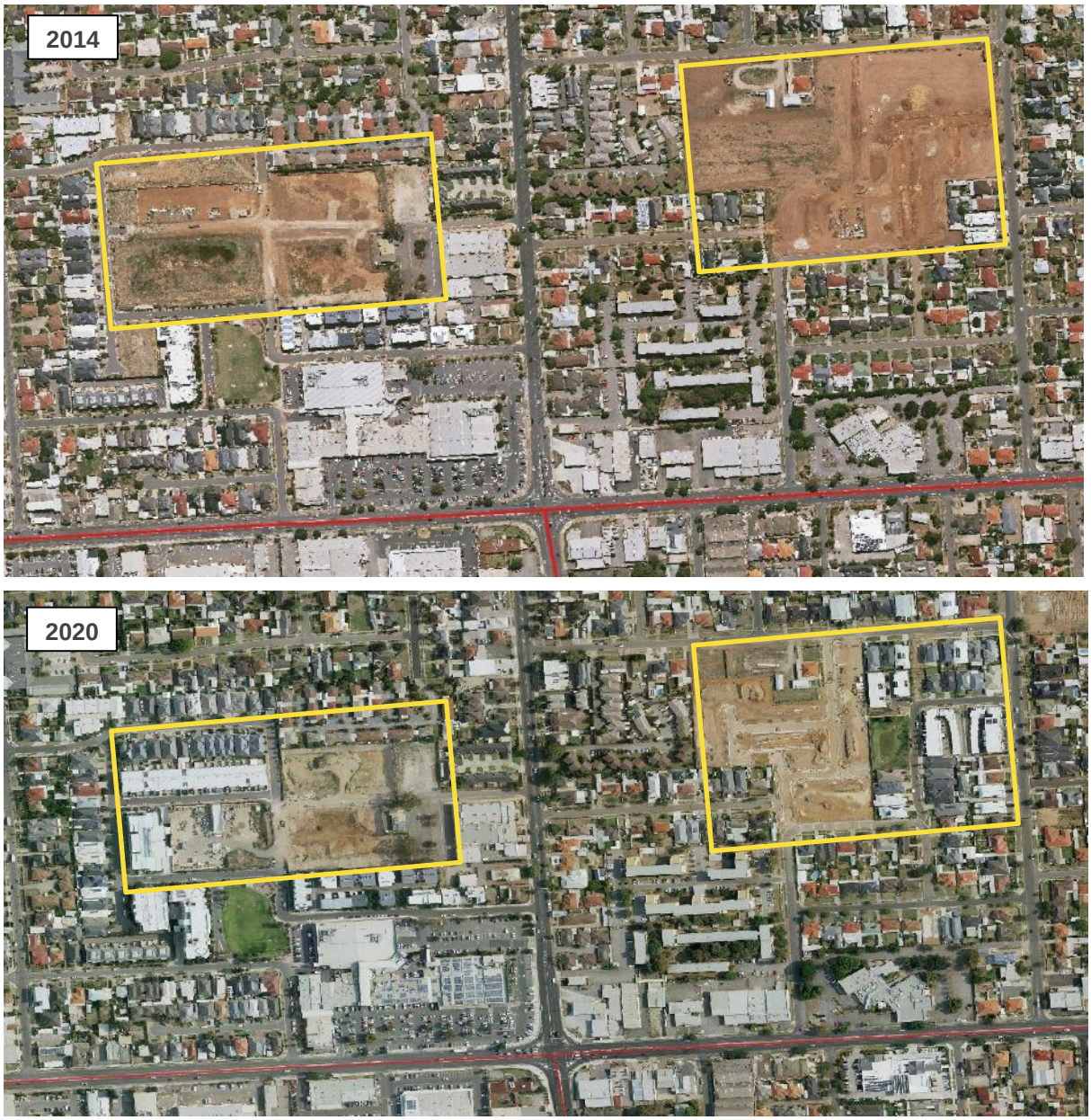

Plate 2. Example of land conversion from classification of plantable space in 2014 (top) to classification of impervious surfaces in 2020 (bottom).

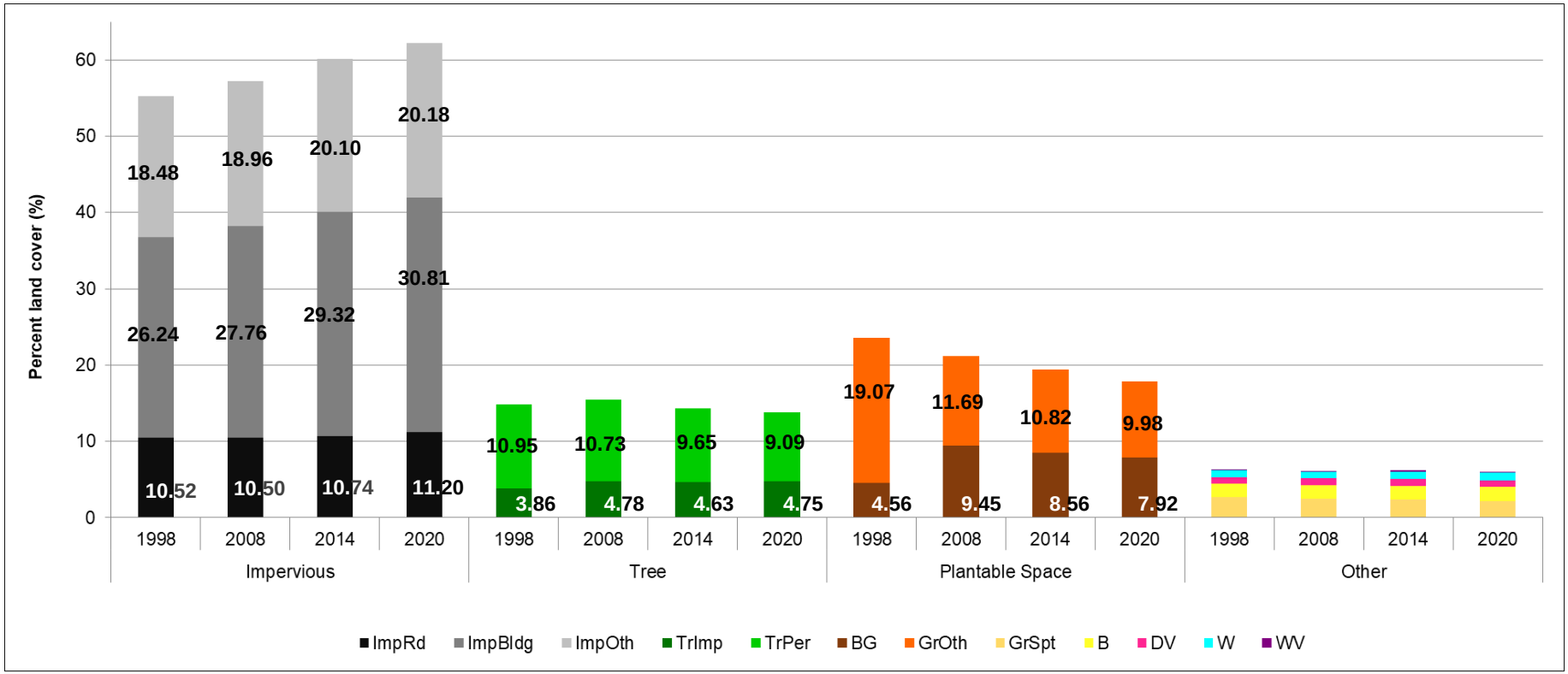

Figure 3. Percent land cover across the City of Charles Sturt in 1998, 2008, 2014, and 2020. Land cover categories abbreviated as follows: ImpRd = impervious – road; ImpBld = impervious – building; ImpOth = impervious – other; TrImp = tree – impervious; TrPer = tree – pervious; BG = bare ground; GrOth = grass – other; GrSpt = grass – sporting; B = beach; DV = dune vegetation; W = water; WV = wetland vegetation.

3.1.2 Public versus private land

Trends in impervious cover, tree cover, and plantable space varied between private and public tenure, with generally more change occurring on private than public land (Figure 4). The following summarises key trends in land cover change relative to tenure.

Impervious cover: in 2020, significantly more ($p<0.001$)[4] of the City's impervious cover occurred on private than public lands (73.82% and 26.18%, respectively), with significantly more buildings and other impervious cover occurring on private lands and significantly more roads occurring on public lands.

Between 2014 and 2020, the increase in percent impervious cover across the City resulted from increases on both public and private lands of all impervious cover types, though the greatest increase was of buildings on private land. Of the private land in the Council area, the proportion covered by buildings increased significantly by 2.12% since 2014, and 6.83% since 1998. These patterns of land cover change are consistent with urban infill.

Tree cover: in 2020, significantly more ($p<0.001$) of the City's tree cover occurred on private than public lands (63.51% and 36.49%, respectively). More tree cover on private land occurred over pervious surfaces (e.g. lawns and private gardens) than over impervious surfaces, whereas the reverse was true on public land, with more canopy covering impervious surfaces (e.g. footpaths and roads).

The city-wide decline in tree cover observed between 1998 and 2014 in the benchmark report has continued over the last six years to 2020, with tree cover declining from 14.28% in 2014 to 13.84% in 2020. This city-wide trend continued to be driven by the losses on private land outpacing gains on public land; public land tree cover increased by 0.07%, though private land tree cover declined by 0.51%. This trend is mirrored over longer timeframes, with public land tree cover increasing by 0.59% since 1998, and private land tree cover decreasing by 1.56% over the 22-year period.

Plantable space: in 2020, significantly more ($p<0.001$) of the City's plantable space occurred on private than public lands (70.42% and 29.58%, respectively). This is considered to be due to the high proportion of grass lawns and gardens on private land.

Between 2014 and 2020, declines of non-sporting grass and bare ground areas occurred on public and private lands, though neither was statistically significant.

Other land cover: in 2020, significantly more ($p<0.001$) of the City's "other" land cover occurred on public than private lands (76.64% and 23.36%, respectively). This trend was true for each of the composite land cover categories, except sports field related grassy areas which occurred more on private than public lands (58.36% and 41.64%, respectively).

The proportion of other land cover remained relatively constant between 2014 and 2020, though there was a small non-significant decline which was largely driven by minor changes to sporting fields on private land, and also fluctuations in water levels over the years which means some point classifications vary between water or wetland vegetation.

[4] Refers to statistical significance. Further details are available in the 2016 report available in Annex A.

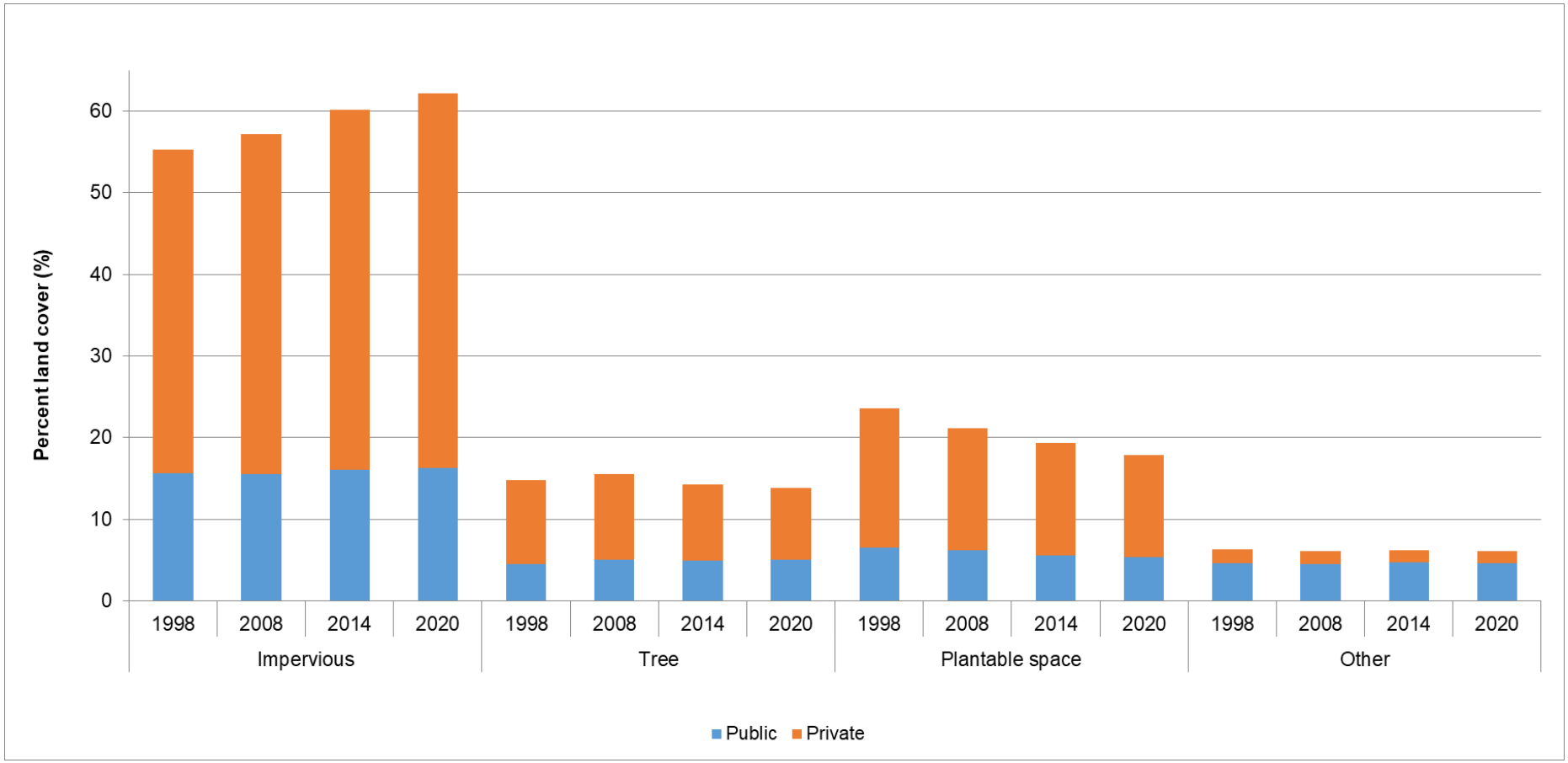

Figure 4. Percent land cover within public versus private land tenure across the City of Charles Sturt in 1998, 2008, 2014, and 2020.

3.2 Suburbs

The following sections provide the key findings of the current and change over time percent land cover analyses for each of the 39 suburbs assessed.

3.2.1 Land cover change trends to 2020

As described in the 2016 report, percent **impervious cover** was still greatest in Hindmarsh (83.06%) closely followed by Kilkenny (81.65%), and Tennyson still had the lowest percent cover (34.12%) (Figure 5). Therefore although the percentage cover in these suburbs had changed, their relative ranking with regards to the amount of cover in relation to other suburbs remains that same. Changes in other suburbs though did alter their relative ranking with respect to percentage cover since 2014. Of the 39 suburbs, 32 had an increase in impervious cover from 2014 (Figure 6); six suburbs had an apparent decline in impervious cover, and the percentage of impervious cover remained unchanged in Ovingham (Figure 5).

Since 2014, the greatest increase in impervious cover (7.06%) occurred in Beverley due largely to large areas of industrial/commercial development within the relatively small suburb area (Figure 6, Plate 3). The greatest decrease in impervious cover (1.88%) occurred in Woodville. When considered together with the increase in plantable space (bare ground) in this suburb over the same time period, this change in land cover is likely capturing the mid-point of urban infill where one house has been demolished to bare ground but new houses not yet built.

It should be noted though that decreases in impervious cover may also be recorded as tree grow and tree canopy increases to cover impervious surfaces. In this case, points may be assessed as “tree canopy” rather than impervious, despite there being no actual loss of impervious cover. In Woodville, for example, there was a small increase in tree canopy cover which may account for some of the apparent loss of impervious surfaces. However, the much greater increase in plantable space (bare ground) is more likely the driver of decreased impervious cover.

Plate 3. Main industrial/commercial development in Beverley showing bare ground in 2014 (left) and the built infrastructure in 2020 (right)

Of particular note are the statistically significant increases in road cover in Croydon and West Hindmarsh due to the Main South Road upgrade and associated infrastructure (Plate 4). Road cover in Croydon increased by 7.06% (p=0.004) and in West Hindmarsh by 4.94% (p=0.042). This is

particularly important when considering the heat-related impacts of roads and the need to integrate appropriate amounts of tree planting in road corridors at the planning phase. Once built, little opportunity exists to ameliorate this.

Plate 4. Croydon in 2014 (left) and 2020 (right) showing the substantial increase in road cover due to the Main South Road upgrade.

In 2020, of the 39 suburbs, 24 had lost **tree cover** since 2014, 13 had increased, and Woodville North and Findon had remained unchanged. Ovingham still had the highest percentage cover (26.59%), with this cover having increased by 1.18% since 2014 (Figure 5, Figure 6). The lowest percentage tree cover occurred in Athol Park (7.06%), which had decreased by 0.94% since 2014.

Despite the decrease in canopy cover in Athol Park, the percentage cover in 2020 was higher than the suburb with the lowest percentage cover in 2014 (St Clair, 5.88%). This indicates substantial canopy growth (or gain through tree plantings) in those suburbs that were lower in cover in 2014. For example, as posited in the 2016 report, canopy cover in St Clair had increased since 2014 (by 2.35%) due to the numerous plantings conducted as part of the wide-scale residential developments (Plate 5). It is likely this canopy cover will continue to increase over time as the development further establishes and planted trees grow and mature.

Percent plantable space was highest in Woodville West (25.18%) despite this suburb experiencing a 4.71% loss of plantable space since 2014 (Figure 5, Figure 6). St Clair had previously had the highest percent plantable space in 2014 due to the extensive land cover conversion in this suburb. This ongoing land cover conversion has resulted in the greatest loss of plantable space in 2020 (9.18%) as previous potential plantable space has either been planted or built on (Plate 5). The lowest percent plantable space still occurred in Hindmarsh (4.47%), with this suburb also experiencing a 1.88% loss of plantable space largely due to the widening and redevelopment of the Main South Road and Port Road intersection and associated infrastructure.

Other land cover (i.e. water, wetland vegetation, sporting fields, beach and dune vegetation) remained relatively constant between 2014 and 2020.

Plate 5. Example from St Clair showing the ongoing major land conversion and development, from the horse racing track in 2008 (top), to early conversion to residential development in 2014 (middle), to continued development including tree plantings in 2020 (bottom).

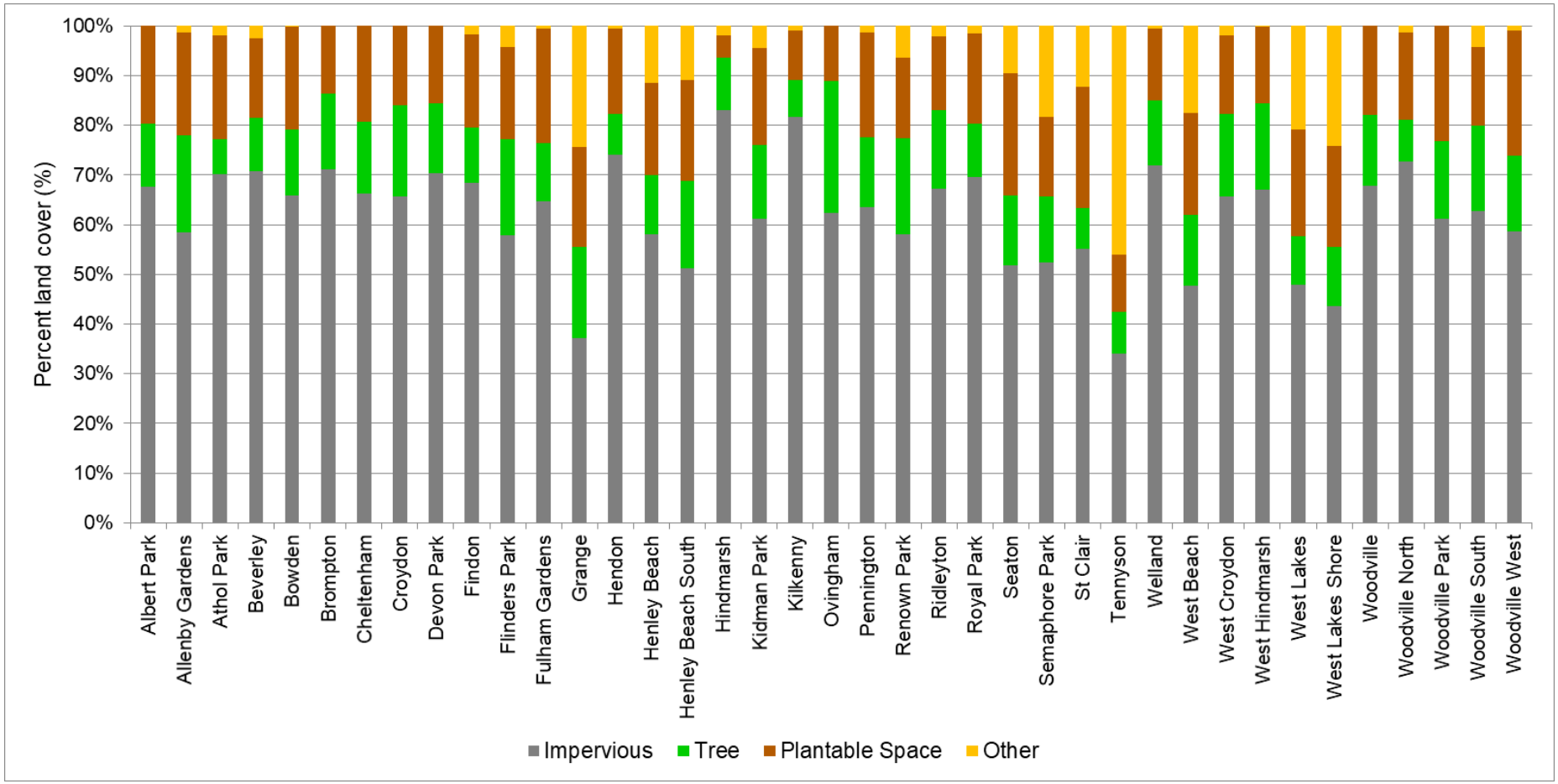

Figure 5. Percent 2020 land cover classes in each suburb. Land cover categories comprising each land cover class are as follows: Impervious = impervious – building + impervious – road + impervious – other; Tree = tree – pervious + tree – impervious; Plantable space = bare ground + grass – other; Other = grass – sporting + beach + dune vegetation + water + wetland vegetation.

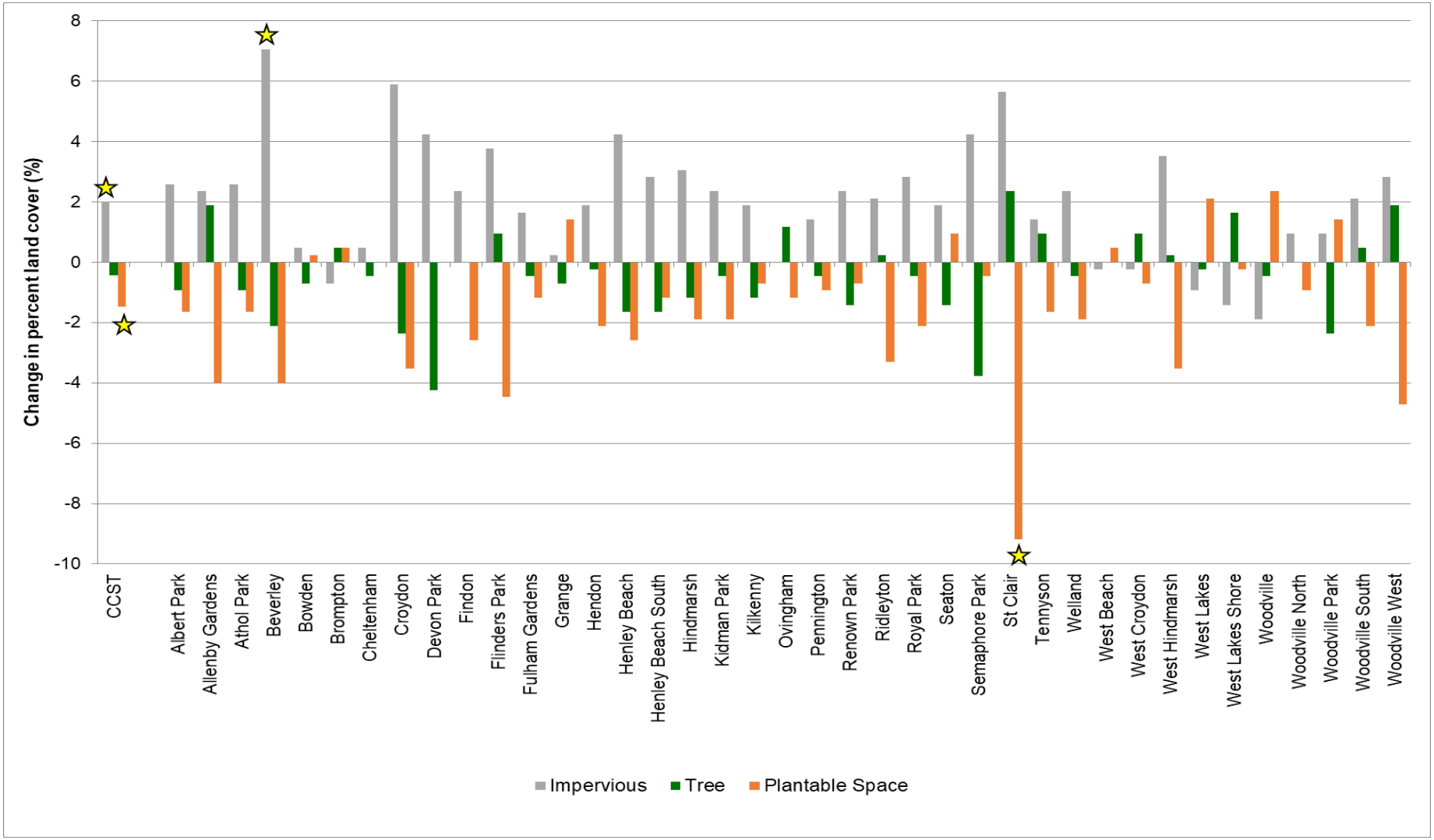

Figure 6. Change in percent impervious, tree, and plantable space cover between 2014 and 2020 in each suburb and across the City of Charles Sturt (CCST). Stars indicate statistically significant changes.

3.2.2 Public versus private land

Impervious cover: In 2020, as in 2014, the highest percentage impervious cover on private land occurred in Kilkenny (66.35%) which had increased 2.12% since 2014, though this was not statistically significant (Table 1). The lowest percent impervious cover on private land also still occurred in Tennyson (22.86%) and had increased by 1.18% since 2014 though also was not a statistically significant change (Table 1). Comparatively, St Clair still comprised the highest percent impervious cover on public land (26.12%), up from 24% in 2014, whereas the lowest occurred in Welland (8.47%) which had decreased by 1.18% since 2014; neither of these losses were statistically significant (Table 1).

The greatest increase in impervious cover on private land occurred in Beverley (6.82%) and in Hindmarsh on public land (2.82%). Whilst the change on public land was not statistically significant, the change on private land was ($p=0.046$).

Tree cover: In 2020, as in 2014, the highest percentage tree cover on private land occurred in Ovingham (17.65%) despite a (non-significant) loss of 0.94% since 2014 (Table 1). The lowest tree cover on private land also still occurred in St Clair (2.82%) despite this suburb having the greatest, and statistically significant, increase in tree cover since 2014 (4.71%, $p=0.007$). This is reflects the extensive new tree plantings that has occurred in St Clair. Of the 39 suburbs, 24 experienced a loss of tree cover on private land since 2014, with the greatest being a significant loss of 4.71% in Devon Park ($p=0.026$). Comparatively, of the 15 suburbs where tree cover increased on private land since 2014, the greatest was in Findon, which had a highly significant increase of 5.88% ($p<0.001$), likely mostly due to existing trees growing bigger.

On public land the highest percent tree cover was in Allenby Gardens (10.59%) which had increased (not statistically significant) by 1.18% since 2014 (Table 1). The lowest public land tree cover occurred in Kilkenny (1.88%) despite a small increase of 0.24% since 2014. Of the 39 suburbs, tree cover increased since 2014 in 18 of them, with the greatest increase being 4.71% in St Clair (Table 1). Comparatively, 18 suburbs also lost tree cover on public land since 2014, with the greatest loss being 2.12% in Woodville Park. Three suburbs remained unchanged in the tree cover.

Plantable space: In 2020, as in 2014, the highest percent plantable space on private land occurred in Woodville West (20.71%) despite a (non-significant) loss of 3.76%. Again like 2014, the lowest cover was in Hindmarsh (2.35%) though this cover had also decreased slightly by 0.47% (Table 1). Hindmarsh also had the lowest percent plantable on public land (2.12%). The greatest percent plantable space on public land still occurred in St Clair (26.12%), with this cover having decreased by 4.24% (not statistically significant) (Table 1).

Between 2014 and 2020, 30 of the 39 suburbs lost plantable space on private land, and 19 lost cover on public land; 15 of these suburbs lost cover on both public and private land (Table 1). The greatest loss of plantable space occurred in St Clair on both private and public lands (4.94% and 4.24%), with the loss on private land being statistically significant on private land ($p=0.33$) but not on public land ($p=0.092$). Eight suburbs experienced an increase in plantable space on private land 16 gained cover on public land; three of these suburbs gained cover on both private and public lands. The greatest increase in plantable space on private land occurred in West Lakes (2.82%) and on public land in Welland (1.41%). Neither of these increases were statistically significant.

Table 1. Percentage land cover in each suburb and tenure type in 2014 and 2020 and the difference in cover between these dates. Listed alphabetically by suburb.

	TREE COVER						IMPERVIOUS COVER						PLANTABLE SPACE COVER					
	Private			Public			Private			Public			Private			Public		
	2014 %	2020 %	Difference	2014 %	2020 %	Difference	2014 %	2020 %	Difference	2014 %	2020 %	Difference	2014 %	2020 %	Difference	2014 %	2020 %	Difference
Albert Park	8.00	7.76	-0.24	5.65	4.94	-0.71	50.35	52.71	2.35	14.59	14.82	0.24	14.82	12.71	-2.12	6.59	7.06	0.47
Allenby Gardens	8.24	8.94	0.71	9.41	10.59	1.18	39.29	41.65	2.35	16.71	16.71	0.00	18.12	15.29	-2.82	6.59	5.41	-1.18
Athol Park	5.18	4.71	-0.47	2.82	2.35	-0.47	52.71	55.29	2.59	14.82	14.82	0.00	18.59	16.47	-2.12	4.00	4.47	0.47
Beverley	9.88	8.24	-1.65	2.82	2.35	-0.47	51.06	57.88	6.82	12.71	12.94	0.24	16.94	12.71	-4.24	3.06	3.29	0.24
Bowden	8.47	6.82	-1.65	5.41	6.35	0.94	45.65	45.18	-0.47	19.76	20.71	0.94	15.06	17.18	2.12	5.41	3.53	-1.88
Brompton	10.12	10.35	0.24	4.71	4.94	0.24	55.29	53.88	-1.41	16.47	17.18	0.71	9.18	10.35	1.18	4.00	3.29	-0.71
Cheltenham	9.65	9.41	-0.24	5.18	4.94	-0.24	50.82	50.82	0.00	15.06	15.53	0.47	15.29	15.53	0.24	4.00	3.76	-0.24
Croydon	14.12	11.76	-2.35	6.59	6.59	0.00	42.12	46.59	4.47	17.65	19.06	1.41	15.06	12.94	-2.12	4.47	3.06	-1.41
Devon Park	12.94	8.24	-4.71	5.41	5.88	0.47	43.29	48.24	4.94	22.82	22.12	-0.71	12.24	12.00	-0.24	3.29	3.53	0.24
Findon	2.35	8.24	5.88	0.71	2.82	2.12	50.35	52.94	2.59	15.76	15.53	-0.24	15.29	13.88	-1.41	6.12	4.94	-1.18
Flinders Park	10.12	10.35	0.24	8.24	8.94	0.71	40.00	43.76	3.76	14.12	14.12	0.00	16.47	12.47	-4.00	6.59	6.12	-0.47
Fulham Gardens	8.00	8.24	0.24	4.24	3.53	-0.71	47.06	48.47	1.41	16.00	16.24	0.24	16.24	14.59	-1.65	8.00	8.47	0.47
Grange	13.88	13.41	-0.47	5.18	4.94	-0.24	27.53	27.53	0.00	9.41	9.65	0.24	14.35	15.76	1.41	4.24	4.24	0.00
Hendon	5.41	4.47	-0.94	3.06	3.76	0.71	55.76	57.65	1.88	16.47	16.47	0.00	14.35	13.41	-0.94	4.94	3.76	-1.18
Henley Beach	8.71	7.53	-1.18	4.71	4.24	-0.47	36.94	40.00	3.06	16.94	18.12	1.18	12.94	11.06	-1.88	8.24	7.53	-0.71
Henley Beach South	10.35	9.18	-1.18	8.71	8.24	-0.47	32.47	34.59	2.12	16.00	16.71	0.71	13.88	12.94	-0.94	7.76	7.53	-0.24
Hindmarsh	3.76	4.00	0.24	8.00	6.59	-1.41	59.76	60.00	0.24	20.24	23.06	2.82	2.82	2.35	-0.47	3.53	2.12	-1.41
Kidman Park	8.94	9.18	0.24	6.35	5.65	-0.71	47.06	49.18	2.12	11.76	12.00	0.24	13.88	11.53	-2.35	7.53	8.00	0.47
Kilkenny	7.06	5.65	-1.41	1.65	1.88	0.24	64.24	66.35	2.12	15.53	15.29	-0.24	8.47	7.76	-0.71	2.12	2.12	0.00
Ovingham	18.59	17.65	-0.94	6.82	8.94	2.12	39.29	40.71	1.41	23.06	21.65	-1.41	7.53	7.06	-0.47	4.71	4.00	-0.71
Pennington	11.29	10.35	-0.94	3.29	3.76	0.47	47.76	49.41	1.65	14.35	14.12	-0.24	15.76	15.06	-0.71	6.12	5.88	-0.24
Renown Park	11.53	9.65	-1.88	9.18	9.65	0.47	38.12	40.71	2.59	17.65	17.41	-0.24	11.76	11.06	-0.71	5.18	5.18	0.00
Ridleyton	10.35	10.59	0.24	5.18	5.18	0.00	50.35	51.53	1.18	14.82	15.76	0.94	11.06	8.71	-2.35	7.06	6.12	-0.94
Royal Park	7.29	7.06	-0.24	3.76	3.53	-0.24	47.29	50.12	2.82	19.53	19.53	0.00	14.35	12.00	-2.35	5.88	6.12	0.24

	TREE COVER						IMPERVIOUS COVER						PLANTABLE SPACE COVER					
	Private			Public			Private			Public			Private			Public		
	2014 %	2020 %	Difference	2014 %	2020 %	Difference	2014 %	2020 %	Difference	2014 %	2020 %	Difference	2014 %	2020 %	Difference	2014 %	2020 %	Difference
Seaton	11.76	10.59	-1.18	3.76	3.53	-0.24	36.47	38.35	1.88	13.41	13.41	0.00	19.76	20.24	0.47	4.00	4.47	0.47
Semaphore Park	11.06	8.71	-2.35	5.88	4.47	-1.41	33.65	37.18	3.53	14.59	15.29	0.71	10.82	9.65	-1.18	5.65	6.35	0.71
St Clair	0.47	2.82	2.35	0.71	5.41	4.71	25.41	28.94	3.53	24.00	26.12	2.12	15.53	10.59	-4.94	18.12	13.88	-4.24
Tennyson	5.18	5.88	0.71	2.12	2.35	0.24	21.65	22.82	1.18	11.06	11.29	0.24	6.59	4.94	-1.65	6.59	6.59	0.00
Welland	9.41	9.18	-0.24	4.00	3.76	-0.24	60.00	63.53	3.53	9.65	8.47	-1.18	14.35	11.06	-3.29	2.12	3.53	1.41
West Beach	8.47	8.24	-0.24	5.65	5.88	0.24	33.88	34.35	0.47	14.12	13.41	-0.71	13.41	13.41	0.00	6.59	7.06	0.47
West Croydon	9.88	10.12	0.24	5.88	6.59	0.71	47.29	48.00	0.71	18.59	17.65	-0.94	13.88	12.94	-0.94	2.59	2.82	0.24
West Hindmarsh	10.82	11.29	0.47	6.35	6.12	-0.24	45.18	46.82	1.65	18.35	20.24	1.88	14.35	12.24	-2.12	4.47	3.06	-1.41
West Lakes	7.29	5.65	-1.65	2.59	4.00	1.41	31.06	30.82	-0.24	17.88	17.18	-0.71	9.18	12.00	2.82	10.12	9.41	-0.71
West Lakes Shore	5.88	7.53	1.65	4.47	4.47	0.00	31.29	30.12	-1.18	13.65	13.41	-0.24	11.29	10.82	-0.47	9.18	9.41	0.24
Woodville	10.12	9.41	-0.71	4.71	4.94	0.24	50.12	48.94	-1.18	19.53	18.82	-0.71	12.47	14.35	1.88	3.06	3.53	0.47
Woodville North	6.12	6.35	0.24	2.35	2.12	-0.24	59.06	60.00	0.94	12.71	12.71	0.00	15.29	14.12	-1.18	3.06	3.29	0.24
Woodville Park	12.24	12.00	-0.24	5.65	3.53	-2.12	46.35	46.35	0.00	13.88	14.82	0.94	18.12	18.35	0.24	3.76	4.94	1.18
Woodville South	13.41	12.71	-0.71	3.29	4.47	1.18	45.41	48.00	2.59	15.29	14.82	-0.47	13.41	11.53	-1.88	4.47	4.24	-0.24
Woodville West	0.94	3.29	2.35	3.53	2.82	-0.71	39.76	40.94	1.18	16.00	17.65	1.65	24.47	20.71	-3.76	5.41	4.47	-0.94

4 Annex A. 2016 Land Cover Report

Tree Canopy Cover in the City of Charles Sturt

Benchmark Assessment

30 August 2016

seed
consulting services

Tree Canopy Cover in the City of Charles Sturt – Benchmark Assessment

A report prepared for the City of Charles Sturt

Prepared by
Seed Consulting Services
106 Gilles Street, Adelaide, South Australia 5000
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Report should be cited as:
Seed Consulting Services (2016) *Tree Canopy Cover in the City of Charles Sturt – Benchmark Assessment*. A report prepared for the City of Charles Sturt, South Australia.

Front cover photo credits

1	2	3	4	5

1. Jacaranda Tree, 46 Woodville Rd; Panoramio; Photo by: Ray Lucks (2008);
2. Linear Park shaded path, Belgrave Ave; Panoramio; Photo by: Phaedrus Fleurieu (2015);
3. City of Charles Sturt boundary; Google Earth 2015; Compiled by: Jenni Garden;
4. Trees in playground, West Croydon; Panoramio; Photo by: Don Nairn (2010);
5. Urban street trees, Semaphore Park; Photo by: Jenni Garden (2015).

Document Control

Document Information

Information	
Document Owner	City of Charles Sturt
Project ID	619_CCST_iTreeCanopy
Last Saved Date	31 August 2016
File Name	619_CanopyReport_FINAL_170516

Document History

Version	Issue Date	Changes
V1 Draft	14 April, 2016	First draft for comment
Final	17 May, 2016	Council edits incorporated
Final with variation	29 August, 2016	Report amended to include pilot suburb reassessments

Document Approvals

Role	Name	Signature	Date
Project Director	Mark Siebentritt		n/a
Written By	Jenni Garden		12 April, 2016; 29 August, 2016
Checked	Mark Siebentritt		13 April, 2016; 29 August, 2016

Disclaimer

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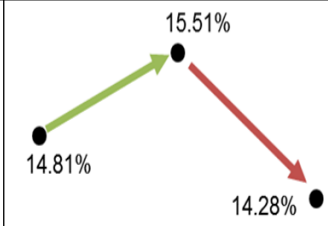
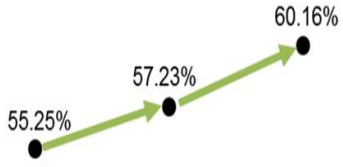
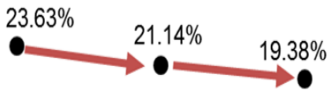
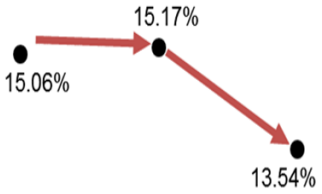
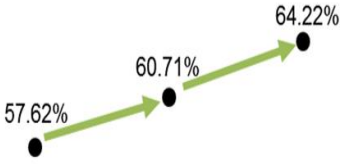
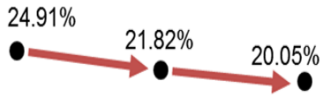
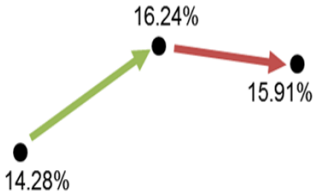
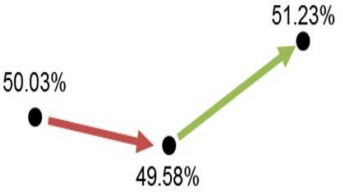
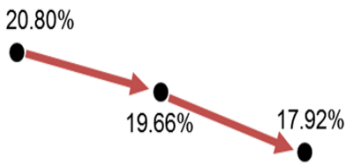
Executive Summary

Green infrastructure is a rapidly advancing focal issue in urban areas nationally and internationally. One of the most dominant elements of green infrastructure is trees – located in parks, public and private gardens, and lining streets and waterways. There exists a long-standing scientific knowledge regarding the beneficial impacts of trees, particularly in urban areas, on human health, environmental health, climate change adaptation, local economy, and real estate values.

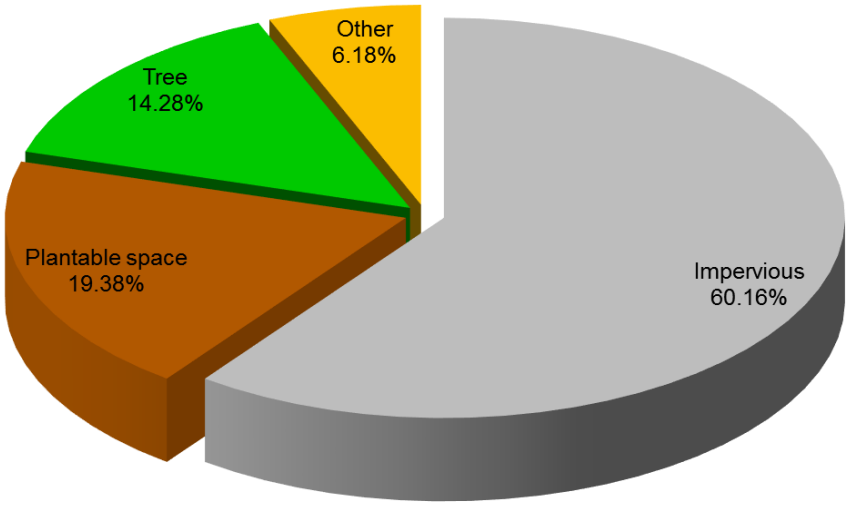
Despite the recognition of the multiple benefits offered by trees, barriers to increasing tree cover in urban areas persist. Further compounding the issue is that local councils managing the "urban forest" are restricted to actions within public and council owned land. This is particularly problematic in higher density residential suburbs, such as those in the City of Charles Sturt, given that the majority of land in the council area is privately owned and managed. Being able to measure and monitor changes (trends) in land cover, particularly tree canopy cover on public and private land will be important for informing decision-making, assessing the success of greening objectives and activity, and prioritising the type and location of activities to best promote desired outcomes.

Based on the findings from this project, the **headline trends in land cover between 1998 and 2014** are shown below. Percent tree (canopy), impervious, and plantable space cover are shown for each time period relative to: (a) the whole city area; (b) private land area; and, (c) public land area.

	Tree (canopy) cover	Impervious cover	Plantable space cover
(a) Total city trends			
(b) Private land trends			
(c) Public land trends			
	1998 2008 2014	1998 2008 2014	1998 2008 2014

An assessment of land cover within the City of Charles Sturt was conducted using the i-Tree Canopy software. Land cover was assessed for 39 suburbs comprising the Council area. In each suburb, land cover was assessed in three time periods (2014, 2008, 1998), and across land tenure (private versus public). Based on these assessments the key findings were as follows:

- current land cover across the City is dominated by impervious surfaces, followed by plantable space, tree (canopy) cover, and other land covers (e.g. water, beach);
    - percent impervious cover is highest in Hindmarsh and lowest in Tennyson;
    - percent tree cover is highest in Ovingham and lowest in St Clair;
    - percent plantable space is highest in St Clair and lowest in Hindmarsh;



- current tree cover (i.e. canopy cover) accounts for 14.28% of the City area (equivalent to approximately 8km2), which is 1.08% higher than that reported in the National Benchmarking Report1, though this difference is not statistically significant;
- compared to 1998 cover levels, impervious cover has increased significantly across the City, plantable space has decreased significantly, and tree cover has decreased (though not significantly);
    - note though that tree cover decline between 2008 and 2014 was significant;
- changes in land cover across the City are driven primarily by changes on private land, for example:
    - impervious cover increased across the city, but more so on private than public land;
- tenure-specific information can be valuable in refining the type and location of programs and activities, for example:
    - St Clair currently provides the most opportunities for implementing Council planting programs, with this suburb containing the highest percent plantable space on public land; and

[1] Jacobs, et al. (2014)

- Woodville West and Findon may be best targeted with community education and incentives programs, as these suburbs experienced the greatest declines in percent tree cover on private land between 1998 and 2014.

These findings serve to highlight that tree/canopy cover in the City of Charles Sturt is declining despite Council's best efforts to increase cover through dedicated planting programs on public land. Such declines in tree/canopy cover present a major challenge for Council meeting future goals around recreation and open space and climate change adaptation, especially given projected rates and extents of on-going urban in-fill. Mitigating future tree loss and moving towards overall canopy cover gain across the City will require complimentary greening actions on public and private land.

The implications of on-going declining tree cover will be wide and varied, with substantial negative impacts on the liveability, prosperity, and long-term resilience of the City. Specific examples include:

- **lower air quality** (e.g. dust and pollutants), which will compromise human health and well-being;
- **hotter average day and night temperatures**, contributing further to the urban heat island effect;
- **decreased shading**, leading to lower use of parks and gardens and higher maintenance costs, as well as increased building cooling costs;
- **increased winds**, which will decrease air quality and the overall liveability and attractiveness of the City;
- **increase localised flooding**, which will directly impact infrastructure and communities and decrease water quality;
- **decreased biodiversity**, which will compromise the functioning of natural and dependent ecosystems; and
- **decreased amenity**, which will decrease property values, liveability, and local economic prosperity, and potentially increase crime rates.

The information derived from this assessment can be used to immediately inform a range of Council decision-making relating to, for example:

- what actions to take and which locations to target in order to achieve the best outcome for resources;
- how local policies and strategies may be amended in order to facilitate urban greening objectives; and
- future spatial analyses to help further refine priority activities and locations, such as planting programs targeted to address thermal hotspots and facilitate climate change adaptation by vulnerable members of the community.

1 Introduction

Green infrastructure is a rapidly advancing focal issue in urban areas nationally and internationally. Referring primarily to the living green elements found in cities (i.e. plants), increasing green infrastructure is being increasingly recognised as a key mechanism for helping to: mitigate climate change impacts and urban heat island effects, improve air and water quality, contribute to biodiversity conservation, increase local economic prosperity and property values, decrease energy requirements of buildings, and enhance the health and well-being of people living and working in urban areas.

One of the most dominant elements of green infrastructure is trees – located in parks, public and private gardens, and lining streets and waterways. There exists a long-standing scientific knowledge regarding the beneficial impacts of trees, particularly in urban areas, on human health, environmental health, climate change adaptation, local economy, and real estate values. Recent public and political developments within Australia[2] further support the importance of trees in our urban areas and underpin the growing momentum by local governments to understand, maintain, and enhance their urban forests.

Despite the recognition of the multiple benefits offered by trees, and the recent drive to increase canopy cover in urban areas, two key barriers to increasing tree cover in urban areas persist:

- competition for space from opposing land-uses (e.g. residential in-fill development, sporting fields); and
- the difficulty in valuing their worth as an urban asset, such as may be done for built infrastructure (e.g. roads, buildings).

Further compounding the issue is that local councils managing the “urban forest” are restricted to actions within public and council owned land. This is particularly problematic in higher density residential suburbs, such as those in the City of Charles Sturt, given that the majority of land in the council area is privately owned and managed. Enacting programs (e.g. incentives, education, and behavioural change) which encourage tree plantings on private land and elicit support for additional plantings on public land will be important for councils wishing to substantially increase their tree (canopy) cover across their city area.

The i-Tree Canopy software provides a user-friendly, repeatable way to measure and value urban trees. Though not all services provided by trees are able to be readily valued (e.g. benefits for biodiversity and human health), i-Tree assessments provide an initial baseline on which to build the business-case for increasing tree cover in urban areas.

An initial pilot study was undertaken by the City of Charles Sturt in 2014 (Charleton, 2014). This study trialled the i-Tree canopy software and analysis approach on three suburbs (Findon, St Clair, Woodville West). Based on this pilot study, Council decided to continue on to assess all suburbs in the same manner.

Seed Consulting Services (Seed) was engaged by the City of Charles Sturt to assess land cover over time across the whole Council area using the i-Tree Canopy software. The assessment included the following four key tasks:

[2] Such as national actions by 202020 Vision and the Federal Government’s Minister for the Environment.

- assess land cover in all 39 suburbs and three time periods (1998, 2008, 2014);
- assess change in land cover over time;
- assess change in land cover relative to public vs private land;
- provide high level summary of ecosystem service values of trees.

The assessment was based on the approach applied in the pilot study, though with the following five main refinements which are explained further in Section 2:

- fewer points per suburb were assessed in this project compared to the pilot (425 versus 500);
- more land cover categories were classified in this project compared to the pilot (12 versus 4);
- tenure was not incorporated in the definition of land-cover categories, rather was assessed following land-cover classification using a spatially-explicit GIS layer developed specifically for this project;
- spatially-explicit GIS shapefiles were created for the project which may be built-on in future projects and decision-making;
- statistical analyses were conducted to determine relative significance of changes.

1.1 City of Charles Sturt overview

The City of Charles Sturt ("Council") covers a land area of approximately 56km^2 stretching westwards from the Adelaide CBD to the coast (Figure 1). It is bounded to the north by the City of Port Adelaide Enfield, to the east by the City of Prospect and City of Adelaide, to the south by the City of West Torrens, and to the west by the Gulf St Vincent coastline.

Like much of the Adelaide plains, it is considered that pre-European vegetation in the Council area was dominated by native grasslands and grassy woodlands (Bagust & Tout-Smith, 2010; Kraehenbuehl, 1996). It is likely that river red gum and blue gum woodlands would have occurred along the river, and more coastal vegetation communities such as: Melaleuca low woodland, samphire low shrub land, *Olearia* and *Acacia* open heath, *Avicennia* low woodland (mangrove) would have occurred in association with the coastal zones (Bagust & Tout-Smith, 2010; Kraehenbuehl, 1996).

Although now heavily modified, key contemporary features of the Council area include:

- 39 suburbs contained either entirely or partially within the Council boundary.
- 675km of road network, including Port Road, a major connector between the Adelaide CBD and Port Adelaide, which bisects the Council area in a south-east to north-west direction;
- new wetlands and associated underground aquifers created through the "Water Proofing the West" initiative;
- 11.5km of coastline (City of Charles Sturt, 2015), including areas supporting remnant dune vegetation;
- 20km of creek lines (City of Charles Sturt, 2015);
- West Lakes, a created saltwater lake located within the suburb of West Lakes;

- more than 285ha of parks and reserves, and 59ha of sporting grounds (City of Charles Sturt, 2015);
- a diversity of public and private, residential, commercial and industrial buildings and associate infrastructure, including more than 44,000 households and 8,000 businesses (City of Charles Sturt, 2015).

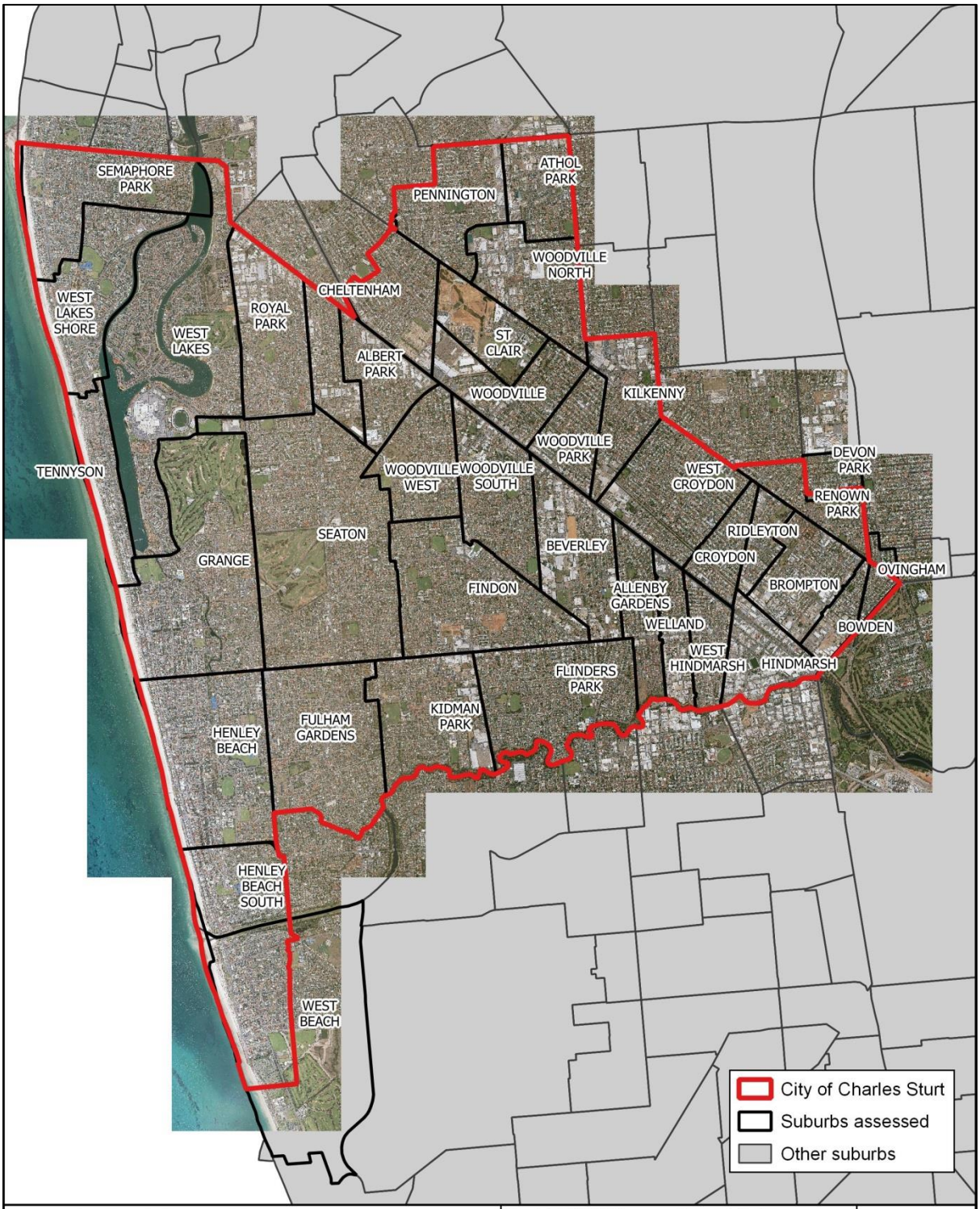


Figure 1. City of Charles Sturt suburbs

Created: 24/08/2016 Drawn: J. Garden
Ref.: 619_F1v2 Datum: GDA94
Data source: City of Charles Sturt; https://data.sa.gov.au
Aerial image source: City of Charles Sturt

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1:55,000

The Council are a progressive local government helping to lead the way in South Australia with regard to greening our urban areas. In particular, the Council understands the role, value and importance of trees in their region, as is clearly stated in their Tree and Streetscape Policy (2014):

> *The City of Charles Sturt values the role and functions of trees and recognises the environmental, aesthetic, economic, and cultural benefits they contribute.*
>
> *Trees are important in:*
>
> *• The creation of a sense of place, unifying architectural forms and creating a sense of unity while linking and softening streetscapes while determining the character of our City.*
>
> *• Improve the local climate by reducing the air temperature, increasing humidity and collectively reducing the urban heat island effect, that is, where urban centres have higher temperatures due to the high number of heat absorbing surfaces with little shade.*
>
> *• Removing carbon dioxide from the atmosphere through the natural process of photosynthesis and storing the carbon (C) in their leaves, branches, stems, bark and roots. Approximately half the dry weight of a tree's biomass is carbon.*
>
> *• Providing habitat for native flora and fauna.*

The value of trees also permeates, to varying degrees, through a number of other policies, strategies, programs, and project initiatives which Council undertake or are involved, including for example, Council's:

- Environmental plan, "Living Green to 2020";
- "Community Plan 2013-2027";
- "Regional Public Health Plan 2014-2019"
- "Development Plan" and associated "Strategic Directions Report Development Plan Review 2014";
- "Management Plans for Community Land"
- crime prevention through environmental design policy;
- Open space strategy;
- identification and protection of "regulated" and "significant" trees;
- involvement in the climate change adaptation planning project, "AdaptWest";
- partnership with 'Canopy' to off-set their emissions through planting trees;
- tree screen renewal;
- trees for the future;
- reactive tree planting program; and
- Planet Ark

1.2 Objectives

The primary objective of this project was to establish metrics of the change of tree canopy cover on public and private land which may then be used to establish a benchmark of tree canopy cover and inform future decision-making regarding tree management, the efficacy of tree planting programs, and action prioritisation.

Accordingly, this report will:

- detail the methods used for the assessment and describe the metrics used;
- present the assessment findings, specifically:
    - the current percent land-cover across the Council area and within each suburb;
    - the change in percent land-cover over time across the Council area and within suburbs;
- trends in land-cover between public versus private land; and
- provide recommendations for future priority actions with regard to maintaining and increasing canopy cover in the region.

2 Approach and Methodology

2.1 Survey area

All 39 suburbs (Table 1, Figure 1) were assessed using the approach described below. The three pilot suburbs[3] (Woodville West, St Clair, and Findon) were also reassessed using the approach herein. Of the 39 suburbs assessed, 36 were contained entirely within the Council boundary and three partially overlapped with the Council boundary (Table 1, Figure 1). Only areas within the Council boundary were assessed and so care should be taken when comparing suburb-level assessments of land-cover for the three partially-contained suburbs with entirely contained suburbs.

Table 1. The 39 suburbs, and their areas, assessed for this project. Note that suburbs only partially contained within the CCST boundary are shown in bold and only the area falling within CCST is shown.

SUBURB	AREA (ha)	SUBURB	AREA (ha)	SUBURB	AREA (ha)
Albert Park	92	Hendon	71	St Clair	94
Allenby Gardens	83	Henley Beach	266	Tennyson	89
Athol Park	92	Henley Beach South	113	Welland	60
Beverley	151	Hindmarsh	88	**West Beach**	**159**
Bowden	41	Kidman Park	180	West Croydon	170
Brompton	111	Kilkenny	109	West Hindmarsh	62
Cheltenham	114	**Ovingham**	**16**	West Lakes	429
Croydon	57	Pennington	136	West Lakes Shore	177
Devon Park	**6**	Renown Park	62	Woodville	122
Flinders Park	216	Ridleyton	42	Woodville North	141
Findon	245	Royal Park	164	Woodville Park	76
Fulham Gardens	243	Seaton	471	Woodville South	145
Grange	367	Semaphore Park	201	Woodville West	119

[3] Charleton, A., 2014. Tree Canopy Cover Assessment, South Australia: City of Charles Sturt.

2.2 Selection of points

i-Tree Canopy (USDA Forest Service; plus cooperators, n.d.) classifies land cover under randomly allocated points within a user-defined area overlaid on Google Earth imagery. As each point is classified, i-Tree Canopy provides an automated running statistical estimate for each land-cover category of the area (km2) and percent (%) cover within the study area, as well as an uncertainty estimate (i.e. standard error, SE). Accordingly, the more points that are classified, the lower the standard error and the more precise the estimated result should be. However, the more land-cover categories defined, the more points that need to be classified in order to achieve statistical stabilisation of estimates (Jacobs, et al., 2014).

i-Tree Canopy suggests surveying 500-1000 points per sample area, though the difference in resources required to survey 500 points versus 1000 points can be substantial when multiple areas are involved, with potentially little gain in precision and varying levels of confidence in the outputs. The authors of Australia's national canopy benchmarking report undertook further evaluations and found that between 600-1000 points would tend to provide a standard error of <3% (Jacobs, et al., 2014). However, this again would result in varying confidence levels in outputs given the varying sampling intensity among larger and smaller areas (i.e. likely lower confidence levels for larger areas, and higher for smaller areas).

For this project, a power analysis was conducted *a priori* to determine how the number of survey points per suburb would vary given differing confidence levels (CL) and confidence intervals (CI) (Figure 2). The outputs indicate the number of points which would achieve statistically acceptable levels of error among suburbs of varying sizes whilst limiting the potential for surveying more points than necessary to produce fit-for-purpose outputs. The pilot study percent land-cover and standard error outputs were also assessed to ensure consistency between this project and the pilot project. Based on these analyses, a 90%CL and 4%CI were selected, which equated to 425 points per suburb (Figure 2). This can be interpreted as surveying 425 points provides at least a 90% confidence level that the estimated outputs of land cover percentages are within 4% of actual cover percentages in each suburb. In order to greatly improve on these confidence levels and intervals, 600 or more points would need to be surveyed (Figure 2).

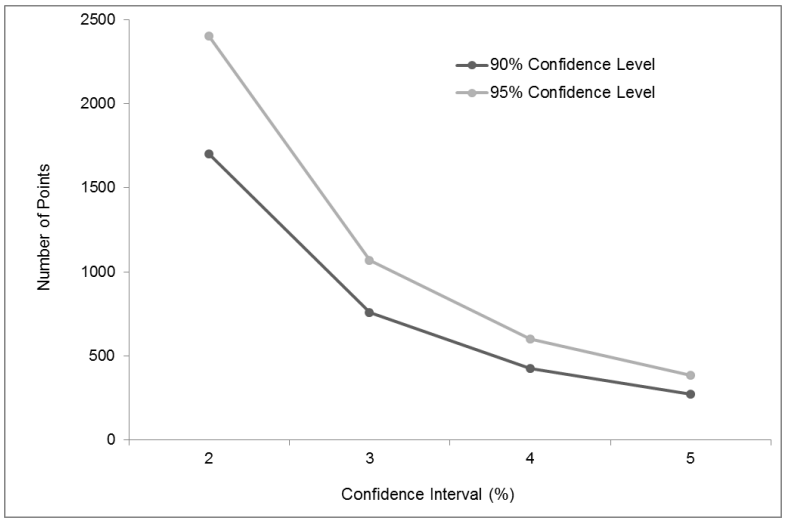

Figure 2. Power analysis output showing number of points required to ensure minimum confidence levels (90% or 95%) and confidence intervals (2-5%) in the reported outputs.

2.3 i-Tree Canopy assessment

Each suburb was assessed as a separate i-Tree Canopy project, classifying 425 points per suburb. Establishing each project requires specific information about the study area and land cover categories to be provided in the i-Tree Canopy settings; these are detailed in the following sections.

2.3.1 i-Tree Canopy settings

The settings used when establishing each i-Tree Canopy project were as follows:

- project location: California – urban
    - the i-Tree Canopy software calculates approximate ecosystem service benefits provided by trees as part of the output. These calculations are based on USA-specific metrics related to weather and pollution and tree species. In order to run an i-Tree Canopy project a USA location must be selected. For the purposes of this project, 'California – urban' was selected, as this is considered the closest USA climatic analogue to the study area in South Australia;
- land cover categories
    - these are user-defined categories entered in to the i-Tree Canopy settings (see Section 2.3.2);
- benefit options: Tree-impervious and Tree-pervious (see Table 3);
    - this setting identifies which of the land-cover categories represents "tree cover"
- currency: AUD $
- units: metric

2.3.2 Land-cover categories

Land-cover categories were required to be consistent with the pilot project conducted within the City of Charles. The pilot project used the same four land-cover categories applied in the national canopy benchmarking report (Jacobs, et al., 2014): tree, grass/bare ground, shrub, and hard surface. These categories though are too broad to be of real relevance for local government on-ground planning and management as they will tend to over-estimate certain attributes (e.g. plantable space represented by grass/bare ground) and limit the potential for more refined analyses of potential plantable opportunities or impervious cover to be examined.

Accordingly, this project defined 12 land-cover categories (Table 3; Plate 1) which allow a more detailed understanding of land cover in the City. The categories were specifically defined to nest within those used in the pilot study in order to allow for direct comparisons if required (Table 3). When defining land cover categories, consideration was given to providing a realistic estimate of space available to plant more trees (i.e. plantable space) and also allow for future refinement of other land cover categories (e.g. impervious surfaces). For example, the two "grass" categories used differentiate between grassed sporting fields and non-sporting grassed areas, as it is highly unlikely that sporting grounds would be viewed as opportunities for planting trees; note that only the active playing area was classified as sporting fields, with grass areas surrounding some sporting fields being classified as non-sporting grassed areas as the may have some space for shade. In addition, the tree category was classified as being over pervious or impervious surfaces, based on the

surrounding land use. This allows for future refinement of impervious surfaces and plantable space if so desired.

Table 2. Land-cover categories used for analysis, compared to those used in the pilot analysis. Note that the categories used in this analysis were consistently applied irrespective of tenure (i.e. public or private land).

LAND-COVER CATEGORIES		CODE	DESCRIPTION
Pilot Analysis	This Analysis		
IMPERVIOUS			
Hard surface (private and public)	Impervious – building	ImpBldg	A building or permanent structure.
Hard surface (private and public)	Impervious – other	ImpOth	Impervious surfaces that aren't buildings or roads, including footpaths, parking lots, railway lines, and pools.
Hard surface (private and public)	Impervious – road	ImpRd	A sealed road; also includes airport runways.
TREE (CANOPY)			
Tree (private and public)	Tree – impervious	TrImp	Tree canopy over perceived impervious surface.
Tree (private and public)	Tree – pervious	TrPer	Tree canopy over perceived pervious surface; includes mangroves.
PLANTABLE SPACE			
Grass/bare ground (private and public)	Bare ground	BG	Non-vegetated pervious surface.
Grass/bare ground (private and public)	Grass - sporting	GrSpt	Grass areas used primarily for sporting purposes, including school ovals and golf courses. Also includes grass areas associated with airports.
OTHER			
Grass/bare ground (private and public)	Grass - other	GrOth	Grass areas not used for sporting purposes, including parks and private lawns.
Not assessed	Beach	B	Coastal, non-vegetated sandy area.
Not assessed	Dune vegetation	DV	Vegetation (shrub and ground cover) growing on coastal dunes.
Hard surfaces* (private and public)	Water	W	Aquatic or marine water body; does not include pools.
Shrub (private and public)	Wetland vegetation	WV	Fringing and aquatic vegetation associated with wetlands; includes intertidal communities such as samphire.

* Unless wetland body, then grass/bare ground

Plate 1. Google Earth satellite images showing random points over examples of each land cover category (a yellow dot has been used to better show the location of the yellow cross-hair used in i-Tree Canopy).

2.3.4 Land cover assessments

Land-cover in each suburb was assessed in three time periods: 2014, 2008, and 1998. However, note that the decision to reassess the three pilot suburbs was made approximately 8 months following the assessment and reporting for the other 36 suburbs. During this time, the default satellite imagery linked to i-Tree Canopy was updated. This means that all suburbs except the pilot suburbs were assessed for the "current (2014)" time period using satellite imagery dated December 2014, which was the default imagery linked with the i-Tree Canopy software at the time of their assessment. The three pilot suburbs though were assessed using the updated satellite imagery dated July1, 2016. Through discussions with CCST it was considered reasonable to analyse these suburbs with the others assessed using 2014 imagery. All assessments for the "current" time period are referred to as "2014".

The 2008 and 1998 assessments were undertaken using i-Tree Canopy's "change survey" function and comparison with aerial imagery provided by CCST. Based on these assessments, the percent land cover within each suburb and time periods was estimated.

The interpretation of satellite imagery and aerial photos is open to interpretation by the user, which may lead to an inherent level of error in the classification, particularly if the quality of the imagery/photo is poor. Such error was minimized as much as possible through consultation with other users to determine a consensus for contentious points, and also by considering the surrounding land-cover context and comparing images in other time periods. Key interpretation issues faced and decisions made were as follows:

- Non-anthropogenic land-cover changes:
    - any point that fell in the coastal tidal zone was classified as "beach" even though in some photos the point may appear to fall in "water" if the tide is high;
    - seasonal variations may result in a point's land-cover category changing between different assessment dates. For example, a point classified as grass-other in one year/month may be classified as bare ground in another year/month due to changes only caused by seasonal influences. Other similar changes may occur due to fluctuations in water levels in waterways and water bodies;
- Non-conforming land-cover decisions:
    - dirt roads were classified as "bare ground";
    - loose gravel surfaces were classified as "bare ground";
    - golf course sand traps were classified as "grass – sporting" as they are not coastal beaches and are unlikely to offer plantable opportunities;
    - hedges and small garden shrubs were classified as "grass – other" as they are not contributing to tree ecosystem service benefits but are not bare ground;
- Inferred points:
    - user-rationale was used to interpret land-cover under points where shadows impeded a clear view; where necessary, comparison with imagery from other time periods and Google street view were also assessed;
    - where a point fell over a temporary cover (e.g. cars, junkyard debris), the more permanent land cover is classified. For example, a point falling over a boat trailer parked on a grassy area, would be classified as "grass-other" not "impervious – other". Similarly, a point falling over a car on the road would be classified "impervious – road", or over a boat on the water would be classified as "water";

- Photo skew and quality:
    - the quality of aerial photos and satellite imagery (particularly older images) can vary substantially in quality and resolution and so influence the ability to clearly identify land cover (Plate 2); and
    - aerial photos can also appear displaced or skewed due to variation in the capture angles of the aircraft/satellite relative to the feature. This displacement increases as the look angle moves away from a vertical capture angle, and so features at the edge of an image will have more displacement than those directly below the sensor at the time of acquisition. When these photos are georeferenced, this skew can impact on where certain points appear to fall. User interpretation was required in these cases to infer how the photo would appear if not displaced/skewed (Plate 2).

Plate 2. Examples of aerial photo quality and skew variation between years. Yellow dots show a georeferenced location of a classification point. Red arrows indicate the direction of skew.

The 1998 photo has lower quality resolution and a clear imagery join. The skew appears to change land cover from "impervious–other" to "impervious–building", though user interpretation infers the land-cover under the point in 1998 is the same as in 2008.

The 1998 photo has lower quality resolution and a clear imagery join. The skew appears to change land cover from "impervious–building" to "grass–other", though user interpretation infers the land-cover under the point in 1998 is the same as in 2008.

2.4 Change over time and tenure analyses

Examination of percent land cover change over tenure and time was conducted using a GIS and Excel to conduct additional spatial and statistical analyses based on the i-Tree Canopy land cover assessments.

Change in percent land cover between tenure was assessed using a GIS layer developed by the CCST which classified all land within the City boundary as either public or private tenure. Public tenure was defined as the public road network as well as any additional land area owned or managed by the CCST; by default, public land was all other land not covered by the public tenure definition. Approximately 69% of land was classified as private, and 31% as public (Figure 3). A spatial analysis was conducted by overlaying the i-Tree Canopy classified land cover points with the tenure layer and calculating the percent of points within each land cover category falling within public versus private land. This assessment was conducted for the current (2014) time period only.

Change in percent land cover over time was assessed by comparing the difference in percent land cover between pairs of time periods (i.e. 2008 and 2014; 1998 and 2014). This was investigated at the City scale and for each suburb.

2.5 Calculating statistical significance

Statistical significance of changes in percent land cover were calculated using t-tests, which is a statistical hypothesis test used to determine if two data sets differ significantly from each other. When comparing percentages, a one-sample t-test is used if comparing values from a single data set and a two-sample t-test is used if comparing values from different data sets.

For example, in this project, a one sample t-test was used to determine if percentages of land cover categories in the same location and year were significantly different (e.g. in 2014, was percent tree cover significantly different to percent impervious cover?). Comparatively, a two-sample t-test was used to determine if percentages of land cover categories were significantly different between locations (e.g. suburbs or tenure) or across years (e.g. in a given suburb, did percent tree cover change significantly between 1998 and 2014? Or, in 2014 was percent tree cover on public land significantly different to that on private land?).

Differences were considered statistically significant if p-values were less than or equal to the 0.05 critical alpha level (see Attachment A for further details).

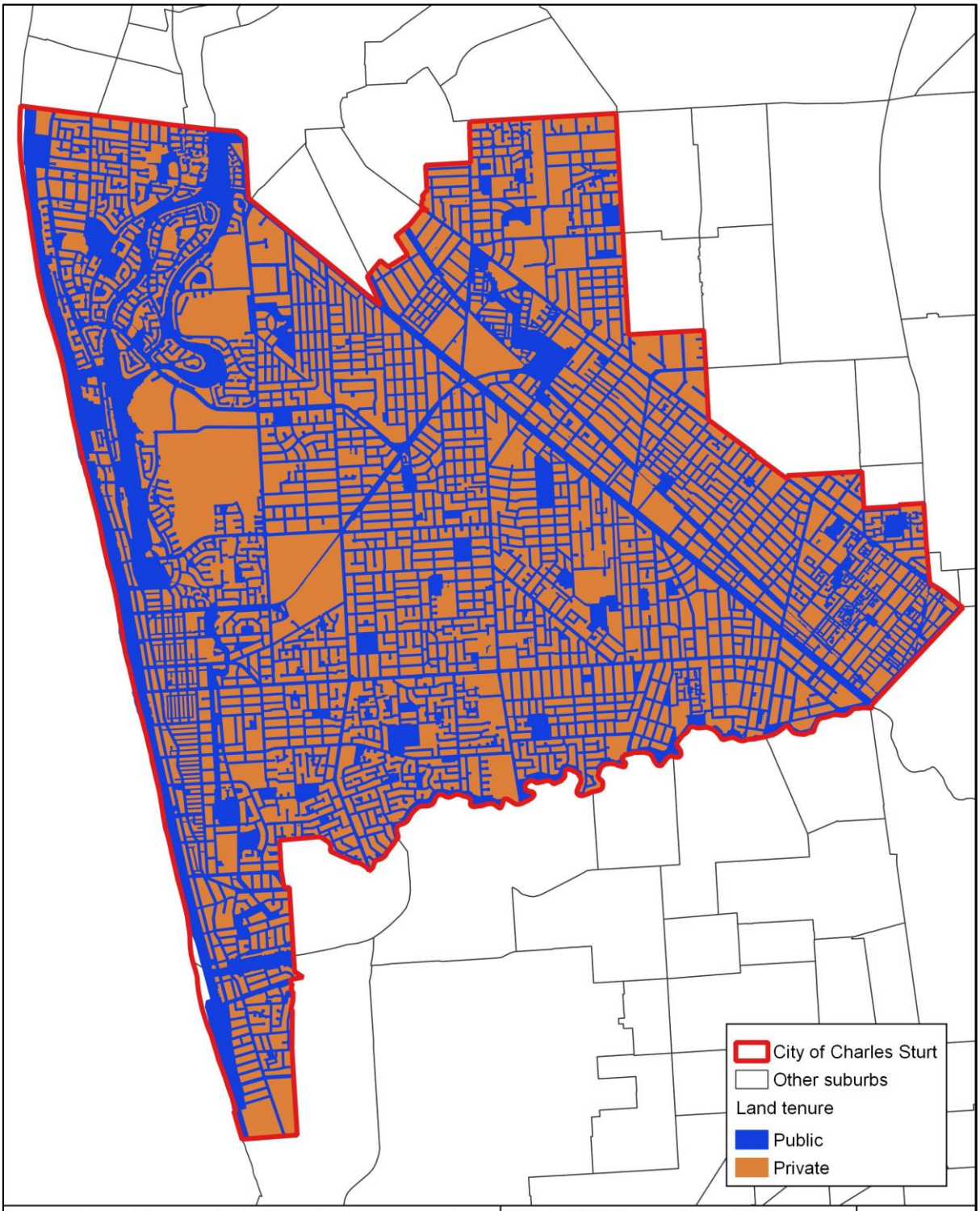

Figure 3. Land tenure within the suburbs assessed

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Data Sources: City of Charles Sturt; https://data.sa.gov.au

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3 Results

A total of 16,575 points were assessed within the City of Charles Sturt (i.e. 425 points in each of 39 suburbs). The following sections present the key findings from across the City of Charles Sturt and also within each of the suburbs assessed during this project. The results from the pilot study on three suburbs are not incorporated in these results.

3.1 City of Charles Sturt

Land cover across the City was calculated by combining the assessments of each of the 39 suburbs assessed. Further details relative to the City, regarding the number of points and associated percent cover for each land cover category in each time period is provided in Attachment B.

3.1.1 Current land cover

In 2014, more than 60% of land cover across the city was classified as impervious surfaces (i.e. building, road or other). This was significantly more ($p<0.001$) than other land cover categories. Buildings comprised almost half of the impervious surfaces in the City (Figure 4). Over 19% of land area was classified as plantable space (i.e. bare ground and grass-other), and was comprised primarily of non-sporting grassed areas. Tree cover within the city was estimated at just over 14% with significantly more of these trees occurring over pervious than impervious surfaces ($p<0.001$) (Figure 4). The combination of grassed sporting areas, beach, dune vegetation, water, and wetland vegetation together comprised the remaining 6.18% of land cover within the City, collectively referred to as “other” land cover (Figure 4).

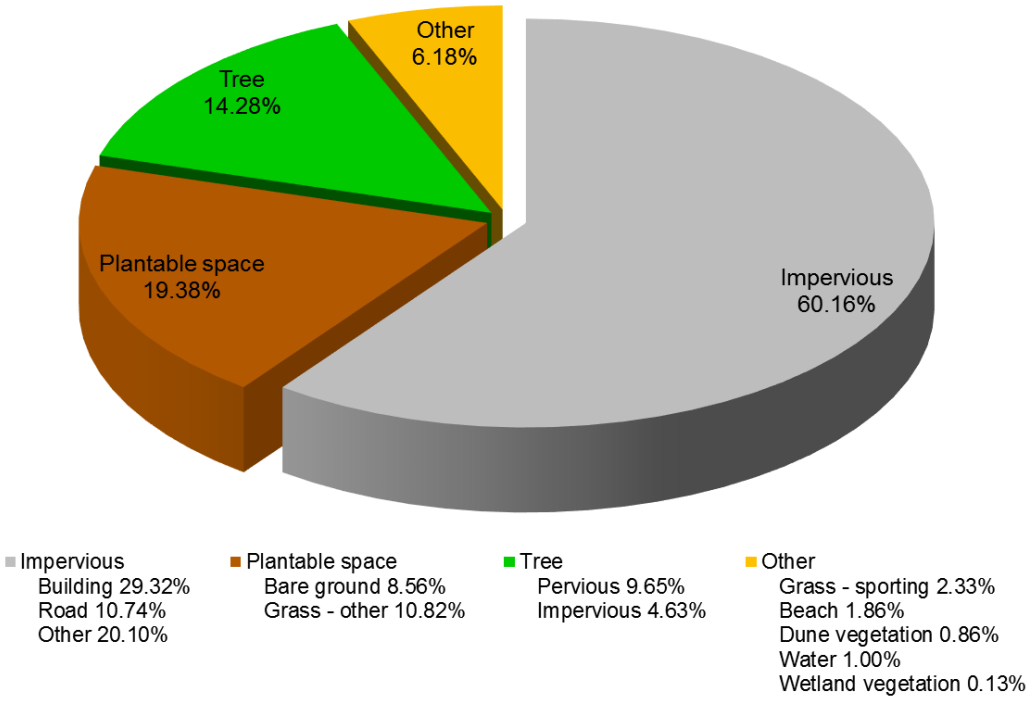

Figure 4. Estimated land cover across the City of Charles Sturt in 2014.

The current tree cover (i.e. canopy cover) of 14.28% across the city is higher than the 13.2% reported in the National Benchmarking Report (Jacobs, et al., 2014), though this difference is not statistically significant (p=0.343). Key differences between the National Benchmarking Report and this analysis which may account for the difference observed, include: the "current" years assessed (2013 and 2014, respectively); and, the number of points assessed (1,000 and 16,575, respectively).

3.1.2 Land cover change over time

Measurable changes in overall land cover across the City were found. The main trends in land cover change across the City between 1998 and 2014 are outlined below. Further details are provided in Attachment B.

Impervious cover: percent impervious cover increased in each time period assessed, from 55.25% in 1998 to 60.16% in 2014 (Figure 5). Each increase was significant, with changes between 1998 and 2008 as well as 2008 and 2014 having p-values of less than 0.001. This change was driven primarily by significant ($p<0.001$) increases in building cover across the City (26.24% to 29.32%) followed by other impervious surfaces (18.48% to 20.10%); road cover did not vary significantly (10.52% to 10.74%, p=0.555) (Figure 5).

Tree cover: percent tree cover was lowest in 2014 (14.28%) and highest in 2008 (15.51%), given a 0.7% increase in cover between 1998 (14.81%) and 2008 (not significant at p=0.076) (Figure 5). The 0.53% decrease in percent tree cover between 1998 and 2014 was not statistically significant. However, the increase in tree cover between 1998 and 2008 meant that a 1.23% decrease in tree cover occurred between 2008 and 2014, which was statistically significant at p=0.002.

The declining tree cover trend was driven by a loss of tree cover over pervious surfaces in each time period, which was greater than the gain in tree cover over impervious surfaces observed between 1998 and 2008; though cover over impervious surfaces also declined between 2008 and 2014 (Figure 5).

Plantable space: percent plantable space decreased significantly in each time period, from 22.65% in 1998 to 18.64% in 2014 (Figure 5). This was despite a significance increase in bare ground between 1998 and 2008, which was offset by a greater decline in grass-other in the same time period.

Other land cover: percent of other land cover (comprised of water, wetland vegetation, beach, dune vegetation and grassed sporting areas) overall remained relatively constant over time, with a non-significant decline of 0.14% (p=0.599) between 1998 and 2014 (Figure 5). The component land cover types however varied somewhat in their trends, with beach and dune vegetation remaining unchanged between 1998 and 2014, grass-sporting decline (not significant), and water and wetland vegetation increased, with the increase in wetland vegetation being significant (p=0.015).

Implications of land cover change over time

The temporal trends observed in impervious, tree, and plantable space cover, may be explained primarily by tree and grass cover being replaced over time by impervious surfaces, as a result of urban in-fill. The increase in bare ground also fits with the urban in-fill explanation, with bare ground being the intermediary stage between the conversion from

green infrastructure to built infrastructure. Some conversion of points from grass to bare ground may also be partially attributed to seasonal variations in the amount of rainfall occurring at the time of the satellite imagery being assessed.

The implications in urban areas of losing green infrastructure, particularly trees, together with increasing impervious cover is well documented, and may include:

- increased urban heat island effects (i.e. increased ambient temperatures), which will have substantial negative implications for human health and well-being, particularly for vulnerable members of the community;
- decreased resilience to climate change impacts, such as increased temperatures (which will exacerbate the urban heat island effect), wind and rainfall intensity associated with storms, and sea level rise;
- decreased human physical and mental health resulting from a loss of interactions with “natural” landscape elements such as trees, and a loss of ecosystem services provided by trees (e.g. oxygen production, carbon storage and sequestration, and air pollution removal);
- increased amount and velocity, and decreased quality, of stormwater run-off, which will have negative ramifications for aquatic and marine environments;
- decreased local economic prosperity and real estate values due to a loss of trees, with trees having been shown to produce more “attractive” places to live and work and treed areas commanding higher property values than non-treed counterparts; and
- decreased biodiversity benefits, such as wildlife foraging and shelter opportunities, and landscape connectivity (which will become particularly important for conserving wildlife species in the plains regions by facilitating range shifts in response to climate change).

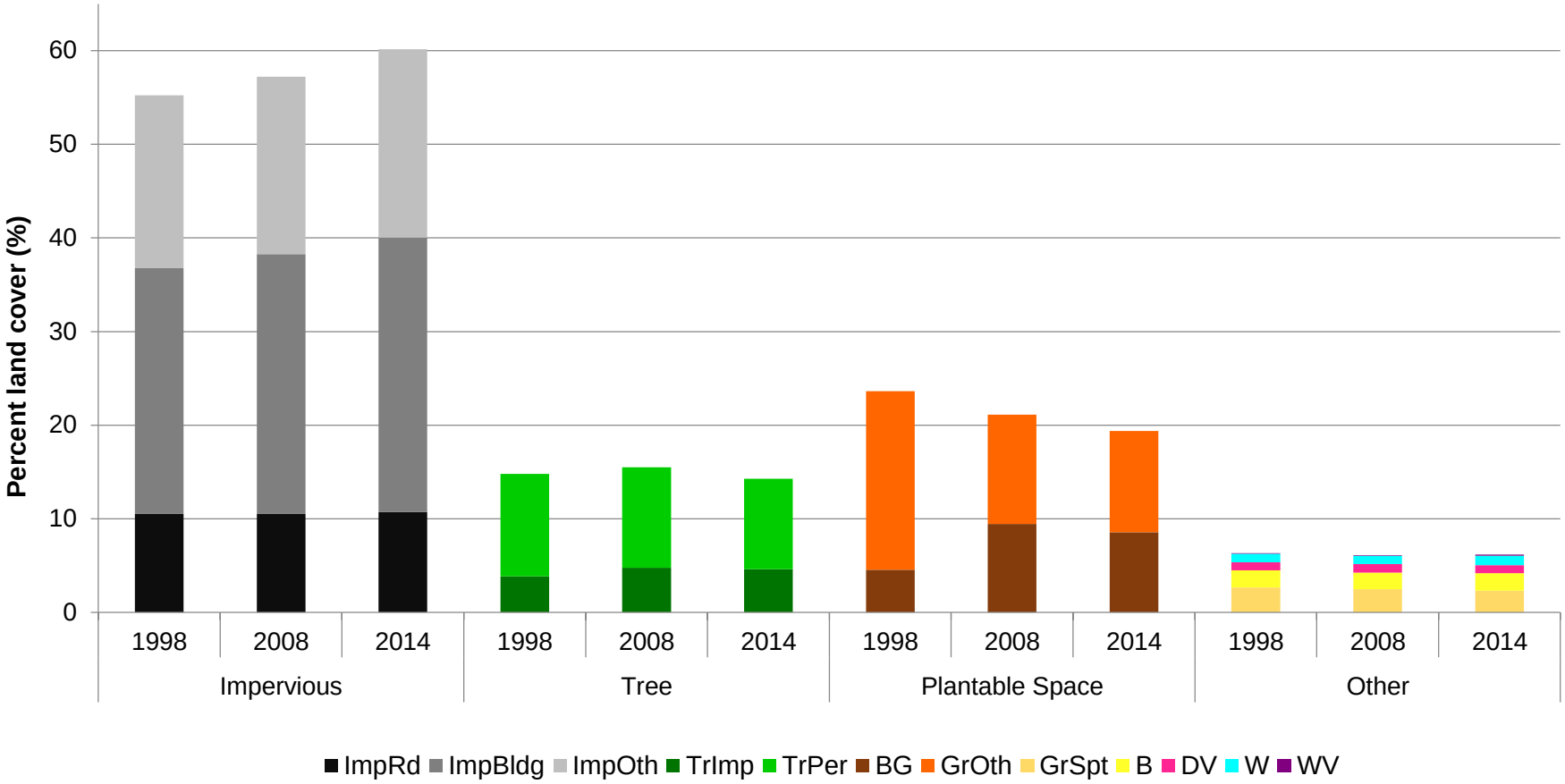

Figure 5. Percent land cover across the City of Charles Sturt in 1998, 2008, and 2014. Land cover categories abbreviated as follows: ImpRd = impervious – road; ImpBld = impervious – building; ImpOth = impervious – other; TrImp = tree – impervious; TrPer = tree – pervious; BG = bare ground; GrOth = grass – other; GrSpt = grass – sporting; B = beach; DV = dune vegetation; W = water; WV = wetland vegetation.

3.1.3 Public versus private land

Trends in impervious cover, tree cover, and plantable space varied between private and public tenure, with generally more change occurring on private than public land (Figure 6). The following summarises key trends in land cover change relative to tenure area (not whole of city area) with further details related to land cover by tenure provided in Attachment B.

Impervious cover: in 2014, significantly more ($p<0.001$) of the City's impervious cover occurred on private than public lands (73.36% and 26.64%, respectively), with significantly more buildings and other impervious cover occurring on private lands and significantly more roads occurring on public lands ($p<0.001$ for all).

Between 1998 and 2014, the increase in percent impervious cover across the City was underpinned by increases on both public and private lands, though significantly more change occurred on private land than public (4.53% versus 0.37%, respectively; $p<0.001$). Increasing building cover on private land was the main driver (3.23% increase between 1998 and 2014).

Tree cover: in 2014, significantly more ($p<0.001$) of the City's tree cover occurred on private than public lands (65.15% and 34.85%, respectively), with more of this tree cover occurring over pervious surfaces than over impervious surfaces on both private and public lands.

The overall decline of tree cover across the City between 1998 and 2014 occurred despite an overall significant ($p=0.02$) increase in cover on public land during this time[4]. Within public lands, the observed increase in tree cover occurred over impervious and pervious surfaces, though only that over impervious surfaces was statistically significant ($p=0.009$). Within private lands, tree cover over impervious surfaces significantly increased ($p=0.21$), though the decrease of tree cover over impervious surfaces was more significant ($p<0.001$).

Plantable space: in 2014, significantly more ($p<0.001$) of the City's plantable space occurred on private than public lands (71.09% and 28.91%, respectively), with this being driven by private lands comprising significantly more ($p<0.001$) non-sporting grassy areas (i.e. grass-other) than bare ground.

Between 1998 and 2014, significant declines of grass-other as well as significant increases in bare ground occurred in both tenures. Within private lands, more than twice as much grass-other was lost than bare ground gained, with this trend also observed on public lands, though to a lesser degree (just over 1.5 times as much grass-other lost than bare ground gained).

Other land cover: in 2014, significantly more ($p<0.001$) of the City's "other" land cover occurred on public than private lands (75.59% and 24.41%, respectively). This trend was true for each of the composite land cover categories, except grass-sporting which occurred more so on private than public lands (59.69% and 40.31%, respectively).

The increase in wetland vegetation between 1998 and 2014 was driven by a significant ($p=0.23$) increase on public land. Grass-sporting declined on both private and public lands, though neither was statistically significant.

[4] Note that a more significant increase in tree cover on public land occurred between 1998 and 2008 ($p=0.005$), though a decline then occurred between 2008 and 2014.

Implications of land cover change by tenure

The current dominance of buildings and other impervious cover on private lands, together with the dominance of road cover on public lands are indicative of highly urbanised areas. The process of urbanisation also explains the increase in impervious cover over time, with urban in-fill being the reason behind the significant increase in building cover on private lands.

Urban in-fill is also the most likely explanation for the trends observed in tree cover on private lands, with an observed increase in tree cover over impervious surfaces occurring as buildings and associated infrastructure are built under existing canopies, but a greater loss of tree cover over pervious surfaces occurring as trees are cleared to make room for urban in-fill. By comparison, the increase in tree cover over time on public land reflects substantial tree planting efforts, particularly of street trees, occurring on council owned and managed lands (see Section 4.1 for further discussion). The potential overall benefits of such efforts though appear to have been undermined by a greater degree of tree clearing on private land, leading to the overall observed loss of tree cover across the City as a whole.

The process of urban in-fill (i.e. increasing impervious surface resulting in decreasing tree cover) is likely to have substantial implications for the overall success of Council objectives relating to canopy cover. For example, if Council has the objective of increasing canopy cover across the City by planting more trees on public land, such objectives may fail to be achieved if clearing of trees and green infrastructure on private land outpaces public plantings. The resulting overall loss of canopy cover will have further implications for the long-term health, economic prosperity, and resilience of the City and its community (refer to implications of green infrastructure loss outlined in Section 3.1.2).

In order for Council to achieve desired greening objectives, it may be necessary to consider a complimentary set of actions which combine tree public planting programs with community education and awareness campaigns and incentives packages. In addition, Council may need to reconsider relevant policies (e.g. development and tree protection policies) in order to achieve a better balance between tree protection and urban development. Given often limited resources, the suburb-scale assessments provided in Section 3.2 will help to refine what actions will be of most use in which locations.

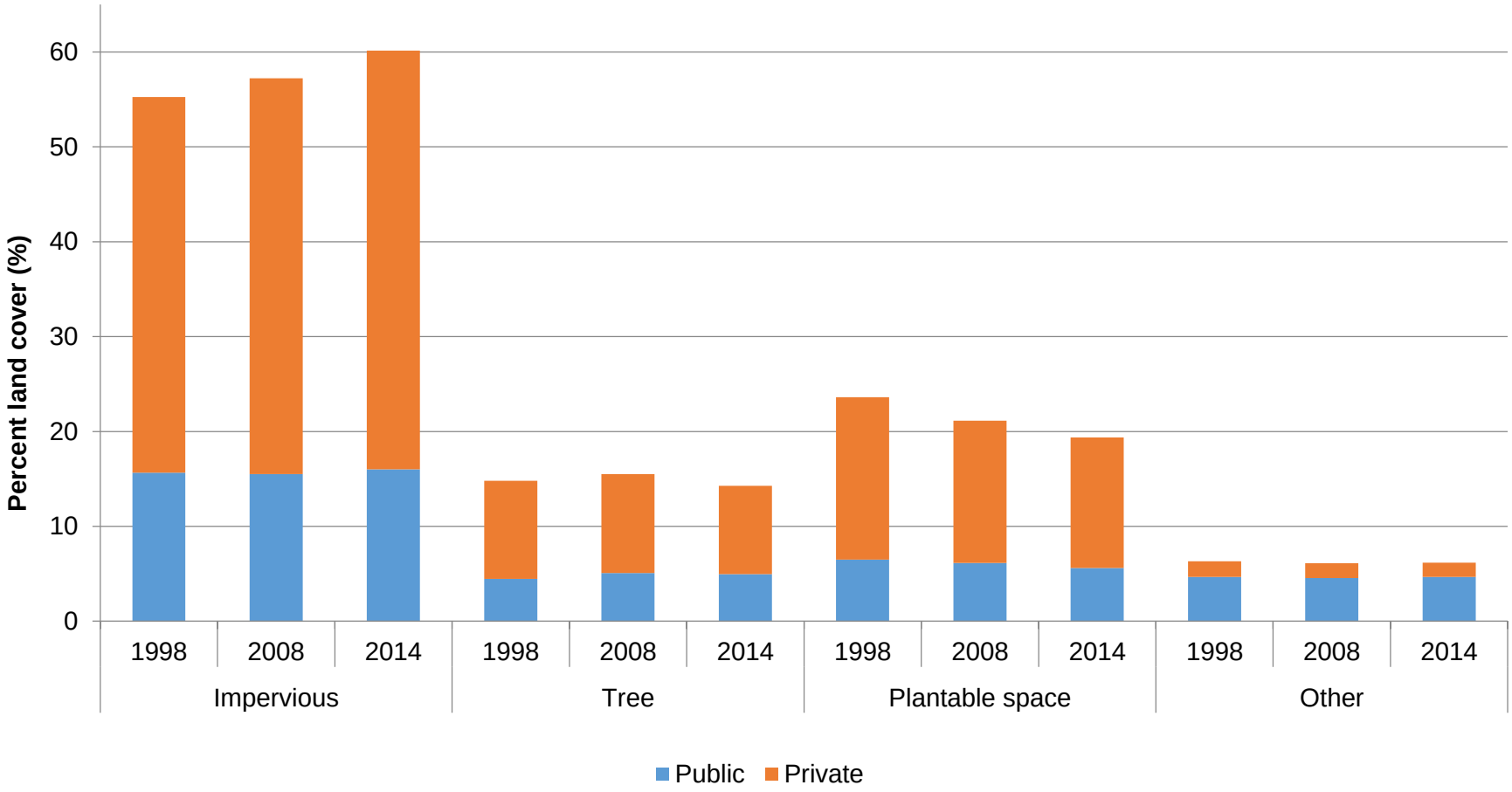

Figure 6. Percent land cover within public versus private land tenure across the City of Charles Sturt in 1998, 2008, and 2014. Land cover is as follows: Impervious = impervious – road +impervious – building + impervious – other; Tree = tree – impervious + tree – pervious; Plantable space = bare ground + grass – other; Other =grass – sporting + water + wetland vegetation + beach + dune vegetation.

3.2 Suburbs

The following sections provide the key findings of the current and change over time percent land cover analyses for each of the 39 suburbs assessed. Further details of land cover in each suburb and time period is provided in Attachment C.

3.2.1 Current land cover

Current land cover varied between suburbs (Figure 7). All suburbs contained impervious, tree, and plantable space cover, though not all suburbs contained other cover categories (i.e. water, wetland vegetation, beach, dune vegetation, grass-sporting) (Figure 7).

Percent impervious cover was greatest in Hindmarsh (80%), closely followed by Kilkenny (79.76%) (Figure 7). Tennyson (32.71%) had the lowest percent impervious cover, likely due to its small relatively small, narrow area coupled with its coastal location meaning it's dominated by beach and dunes which has inhibited development. The next six lowest percent impervious cover levels were also coastal suburbs. Henley beach was the notable coastal suburb exception, with a relatively high level of impervious cover (53.88%), indicative of the active commercial and residential development associated with this popular beach-side suburb. The suburbs with the lowest impervious cover and no beach cover were St Clair (49.41%) and Seaton (49.88%) (Figure 7).

Percent tree cover was highest in Ovingham (25.42%) and lowest in St Clair (5.88%). This low cover in St Clair may be due to the recent extensive land cover changes that have occurred here, from a suburb dominated by a horse racing track in 1998 to a now increasingly residential suburb (Plate 3). As such, canopy cover may be expected to increase over time, assuming that more trees have been recently planted in association with the developments. The suburb with the next lowest tree cover was Tennyson (7.29%), whose high percent beach cover (29.18%) and dune vegetation cover (17.41%) will limit the total tree cover possible within the suburb (Figure 7).

Percent plantable space was highest in St Clair (33.65%) and lowest in Hindmarsh (6.35%) (Figure 7). The high cover in St Clair is likely indicative of the recent extensive land cover transitions that have occurred in this suburb, whereas the low cover in Hindmarsh is likely due to the very high percent impervious cover and moderate tree cover (11.76%) (Figure 7).

Of the suburbs assessed, 15 contained water cover, with West Lakes followed by West Lakes Shore and Semaphore Park containing the highest percent water cover (17.65%, 6.82%, and 5.65%, respectively) due to the large created boating lake which they share, though which predominantly occurs in West Lakes. The lowest percent water occurred in Royal Park and Tennyson (both 0.24%). Nine suburbs contained wetland vegetation cover, with St Cair containing the highest percent cover (2.82%) due to a recently developed artificial wetland (Figure 7; Plate 3). A total of 27 suburbs contained grassy sporting fields, with Grange having the highest cover (19.29%) which was nearly double the amount as the next highest cover in Seaton (10.12%); the lowest percent cover occurred in Bowden and Brompton (both 0.24%).

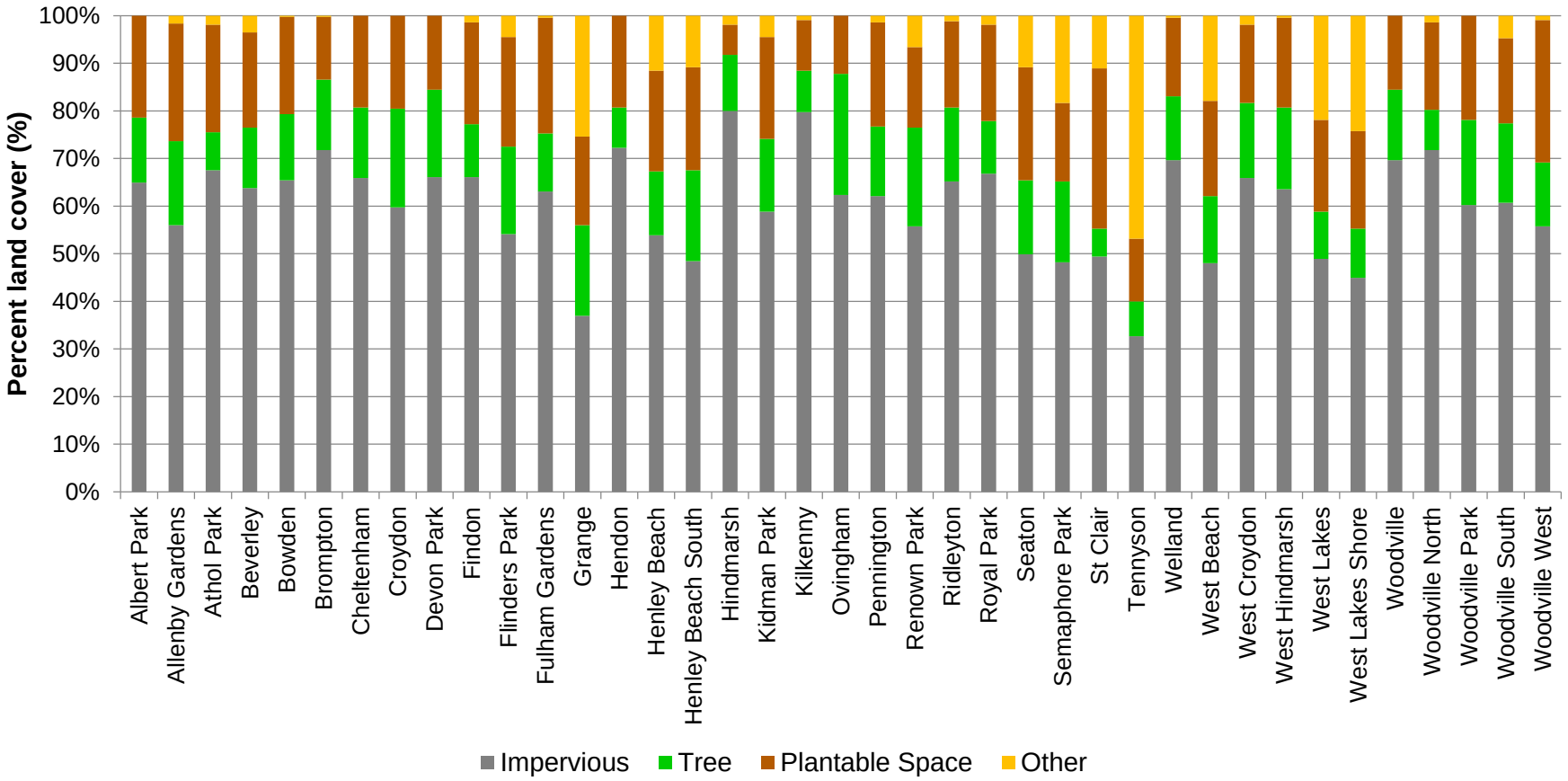

Figure 7. Percent 2014 land cover classes in each suburb. Land cover categories comprising each land cover class are as follows: Impervious = impervious – building + impervious – road + impervious – other; Tree = tree – pervious + tree – impervious; Plantable space = bare ground + grass – other; Other = grass – sporting + beach + dune vegetation + water + wetland vegetation.

Plate 3. St Clair showing substantial land changes that have occurred in the suburb across the three time periods assessed, from predominantly grass cover in 1998, to predominantly bare ground cover in 2008, to predominantly impervious cover in 2016. This also highlights the importance of repeating land cover assessments regularly over time as transitioning land covers can influence the dominant land cover in any one time period.

3.2.2 Land cover change over time

Changes in land cover over time varied among suburbs. For the purposes of this section, only change in impervious, tree, and plantable space cover are discussed for suburbs (Figures 8-10). In addition, for simplicity, only land cover in 1998 and 2014 are compared. Further details of all land cover change in each time period for each suburb are provided in Attachment C.

Impervious cover: percent impervious cover increased in all suburbs except three (Figure 11). The greatest increase (20.71%) occurred in St Clair (28.71% to 49.41%) and was statistically significant at $p<0.001$. This increase in impervious cover was nearly twice as much as the next highest increase in impervious cover in Woodville North (11.76%). Significant increases in impervious cover occurred in 12 suburbs (Figure 11). Decreases in impervious surfaces occurred in Beverley, Devon Park, and Bowden between, with the greatest decrease (4%) occurring in Bowden (69.41% to 65.41%); none of these decreases were statistically significant (Figure 11).

Tree cover: percent tree cover increased in 14 suburbs, decreased in 24, and remained unchanged in West Croydon (Figure 11). The greatest increase in precent tree cover occurred in Brompton, which increased by 4.47% (10.35% to 14.82%), though this was not a statistically significant change ($p=0.05$). Woodville North experienced the greatest decline in tree cover, with the 5.41% decline (13.88% to 8.47%) being statistically significant ($p=0.012$) (Figure 11). No other suburbs underwent significant changes in tree cover between 1998 and 2014.

Plantable space: percent plantable space declined in all suburbs except Bowden and Beverley, in which plantable space increased by 3.06% and 1.65%, respectively (Figure 11). The greatest decline of 14.12% occurred in St Clair (47.76% to 33.65%) and was statistically significant a $p<0.001$. Declines in 13 other suburbs were also statistically significant (Figure 11).

Implications of land cover change over time

Understanding trends in land cover change in each suburb helps to understand changes in City-wide land cover patterns. For example, the increase in impervious cover across the City is reflected by increases in nearly all suburbs, and similarly the decrease in plantable space across the City is reflected by a decrease across most suburbs. Comparatively, patterns in tree cover change were more variable, across suburbs. Of particular interest were the following land cover changes:

- St Clair had the greatest increase in impervious cover and the greatest decrease in plantable space cover, though relatively little decrease in tree cover. These trends are indicative of the extent of land cover conversion that has occurred since 1998, from largely open sporting fields to predominantly residential (Plate 3). The relatively small loss of tree cover which is usually expected with urban development reflects the initial low tree cover in 1998 due to the expansive sporting fields (Plate 3) . Note also that, compared to other suburbs, despite the high increase in impervious cover, St Clair was still one of the suburbs with the lowest levels of overall impervious cover;

- Woodville North had the greatest decrease in percent tree cover and the second greatest increase in percent impervious cover (second to St Clair), which suggests tree cover is being replaced by built surfaces as urban in-fill occurs;
- Brompton had the greatest overall increase in percent tree cover, which together may reflect successful Council tree planting programs in this suburb; and
- Bowden had the greatest increase in plantable space and the greatest decrease in impervious cover. This may suggest this suburb is currently undergoing the most active urban in-fill, though whether built or green infrastructure will replace the lost impervious cover is unable to be determined from these analyses.

Further analysis relating to the contribution of land cover changes on public and private land will help to further refine relevant actions and target locations (see Section 3.2.3).

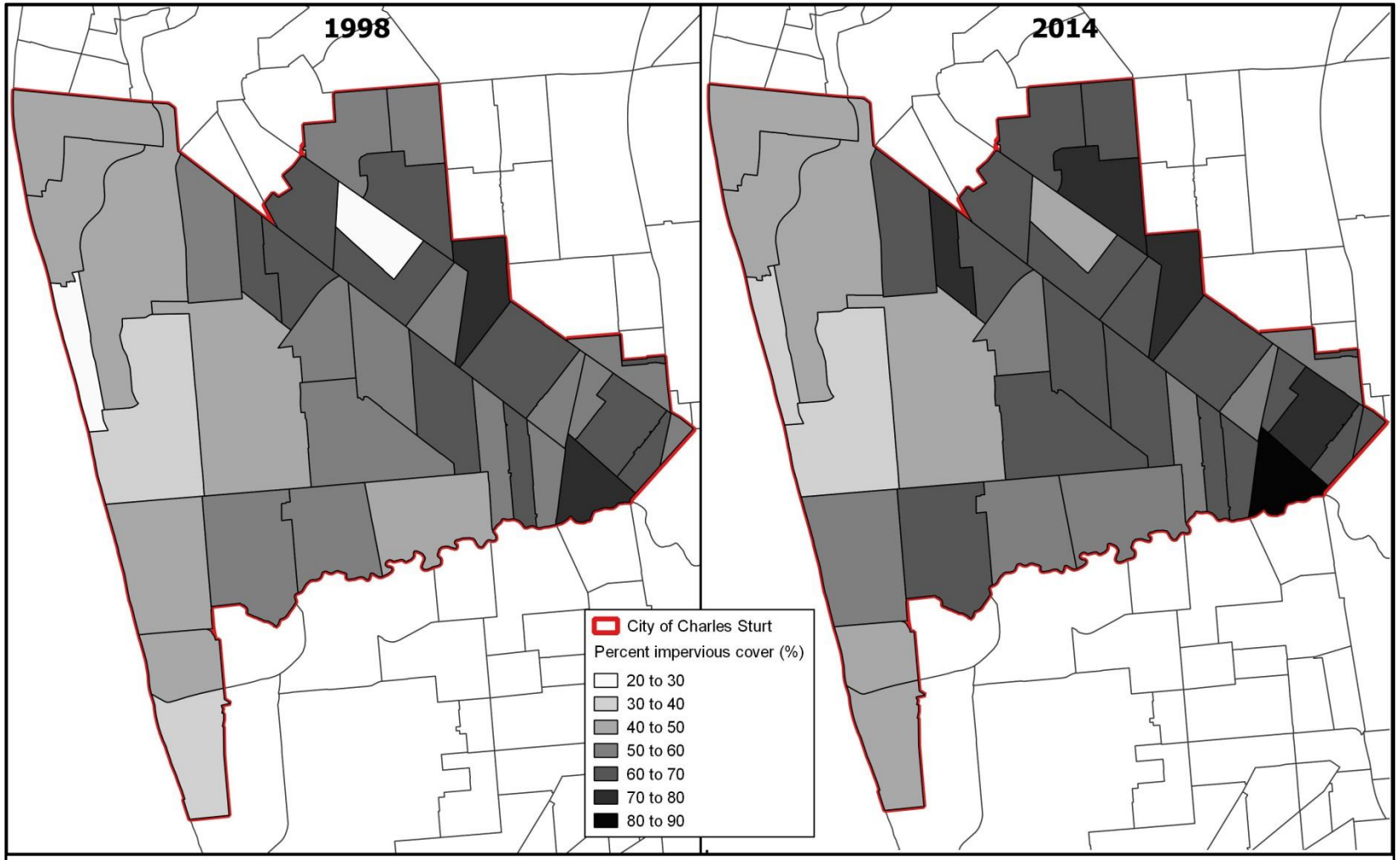

Figure 8. Percent impervious cover class by suburb in 1998 and 2014

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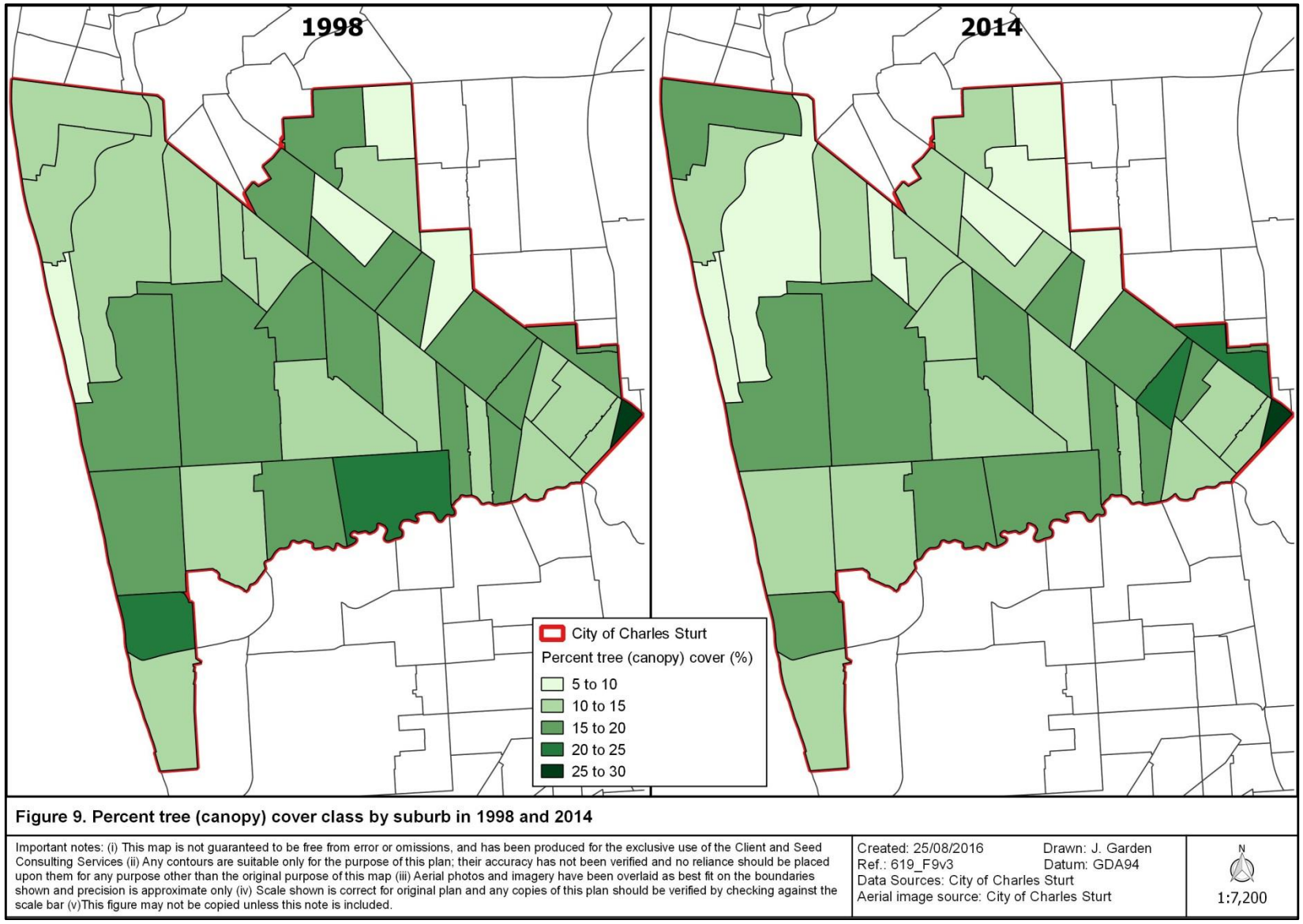

Figure 9. Percent tree (canopy) cover class by suburb in 1998 and 2014

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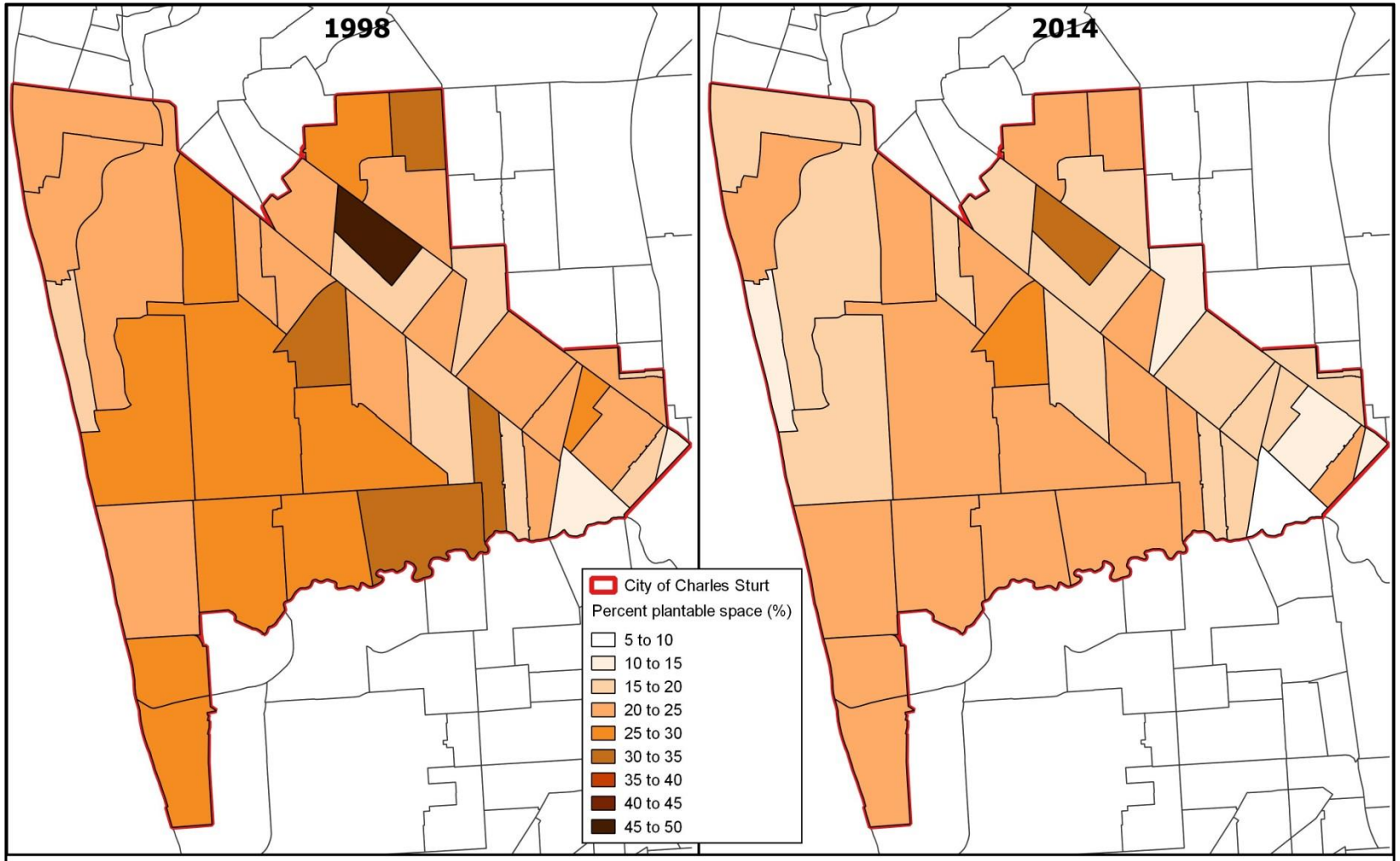

Figure 10. Percent plantable space cover class by suburb in 1998 and 2014

Important notes: (i) This map is not guaranteed to be free from error or omissions, and has been produced for the exclusive use of the Client and Seed Consulting Services (ii) Any contours are suitable only for the purpose of this plan; their accuracy has not been verified and no reliance should be placed upon them for any purpose other than the original purpose of this map (iii) Aerial photos and imagery have been overlaid as best fit on the boundaries shown and precision is approximate only (iv) Scale shown is correct for original plan and any copies of this plan should be verified by checking against the scale bar (v)This figure may not be copied unless this note is included.

Created: 25/08/2016 Drawn: J. Garden
Ref.: 619_F10v3 Datum: GDA94
Data Sources: City of Charles Sturt
Aerial image source: City of Charles Sturt

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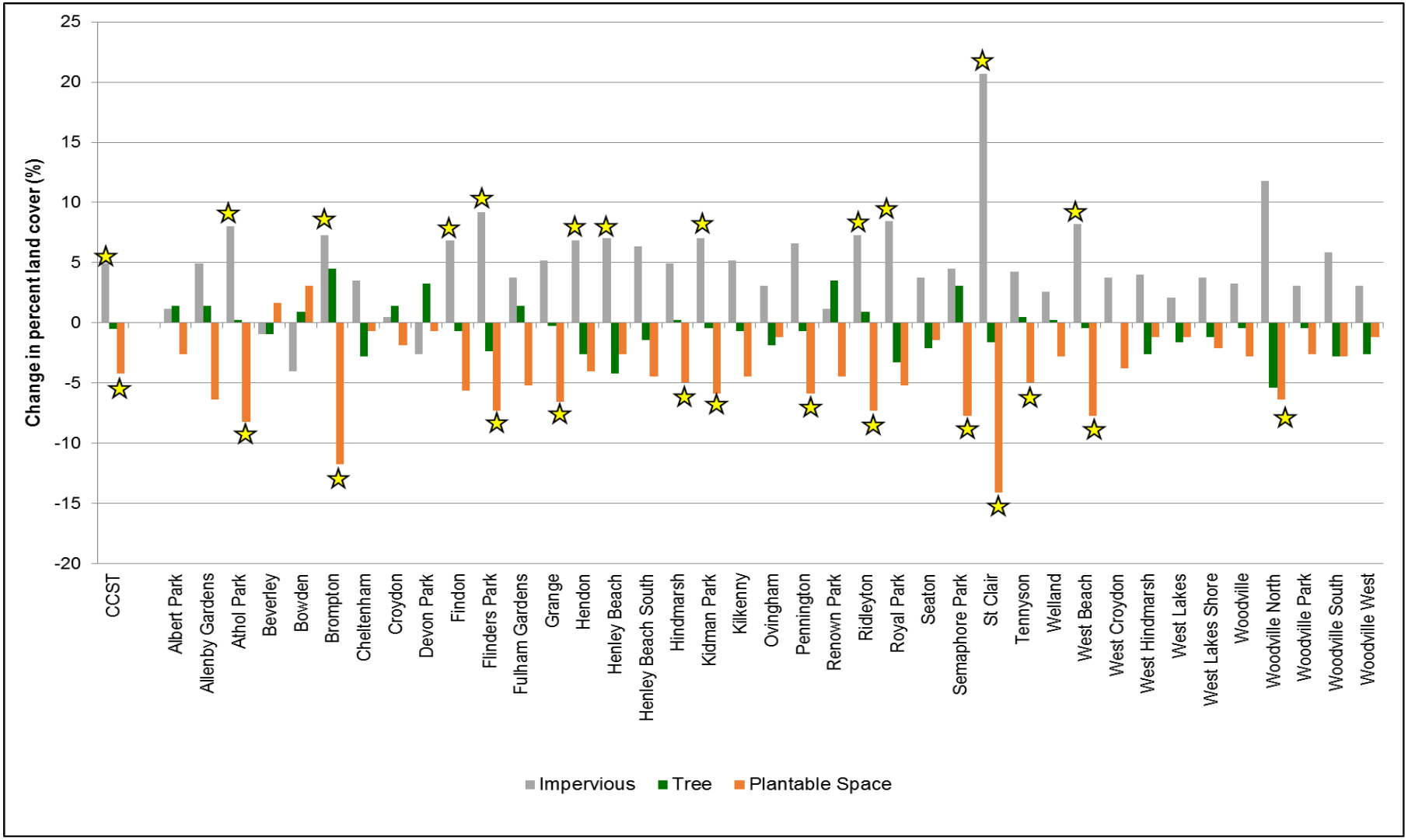

Figure 11. Change in percent impervious, tree, and plantable space cover between 1998 and 2008 in each suburb and across the City of Charles Sturt (CCST). Stars (☆) indicate statistically significant changes. Note that an increase in tree cover across CCST was statistically significant between 2008 and 2014, but the decline between 1998 and 2014, as is shown in this figure, was not significant.

seed consulting services

3.2.3 Public versus private land

For the purposes of this report, key findings of tenure-specific land cover differences in each suburb between 1998 and 2014 are summarised. Further details regarding land cover by tenure in each suburb and time period is provided in Attachments D-F.

Impervious cover: In 2014, the highest percent impervious cover on **private land** occurred in Kilkenny (64.2%) and the lowest in Tennyson (21.6%) (Table 3). Comparatively, St Clair comprised the highest percent impervious cover on **public land** (24%), whereas the lowest occurred in Grange (9.4%) (Table 3).

Between 1998 and 2014, percent impervious cover on **private land** increased in 37 of the 39 suburbs, with the greatest change occurring in Woodville (11.06%). Bowden and Beverley experienced a decline in percent cover by 3.76% and 1.18%, respectively (Table 3). Comparatively, on **public land**, 17 suburbs experienced an increase in percent impervious cover (from 0.24% in seven suburbs to 10.12% in St Clair); 17 suburbs experienced a decrease in percent impervious cover (from 0.24% in nine suburbs to 2.82% in Devon Park), and Woodville South and Grange had no discernible difference in cover (Table 3).

Tree cover: In 2014, the highest percent tree cover on **private land** occurred in Ovingham (18.6%) and the lowest in St Clair (0.47%) (Table 3). Comparatively, on **public land** Allenby Gardens comprised the highest percent tree cover (9.4%), whereas the lowest occurred in Findon and St Clair (0.71% each) (Table 3).

Between 1998 and 2014, percent tree cover declined on **private land** in 28 of the 39 suburbs, by 0.24% in West Lakes, Beverley, and Allenby Gardens to 7.76% and 9.41% in Findon and Woodville West, respectively (Table 3). Nine suburbs experienced an increase in percent cover, by 0.24% in West Croydon to 2.35% in Semaphore Park, and no change was found in Tennyson or Athol Park (Table 3). Comparatively, on **public land**, percent tree cover increased in 25 suburbs (by 0.24% in five suburbs to 3.29% in Brompton) (Table 3). Twelve suburbs experienced a decline in percent tree cover (from 0.24% in Flinders Park and West Croydon to 4.71% in St Clair), and no change was found in Kilkenny and Croydon (Table 3).

Plantable space: In 2014, the highest percent plantable space on **private land** occurred in Woodville West (24.47%) and the lowest in Hindmarsh (2.8%) (Table 3). Comparatively, St Clair comprised the highest percent plantable space on **public land** (18.12%), whereas the lowest occurred in Kilkenny and Welland (2.12%) (Table 3).

Between 1998 and 2014, percent plantable space on **private land** declined in 37 of the 39 suburbs, with the greatest change occurring in Brompton (8.24%). Beverley and Bowden experienced an increase in percent cover of 1.18% and 3.06%, respectively (Table 3). Comparatively, on **public land**, 26 suburbs experienced a decline in percent plantable space (from 0.24% in West Hindmarsh and Albert Park to 11.53% in St Clair); 10 suburbs experienced an increase in percent plantable space (from 0.47% in five suburbs to 1.41% in Hendon); and, Devon Park, Cheltenham, and Bowden had no discernible difference in cover (Table 3).

Table 3. Percent land cover in each suburb in 1998 and 2014 and change in land cover percent between 1998 and 2014. Listed alphabetically by suburb.

	TREE COVER						IMPERVIOUS COVER						PLANTABLE SPACE COVER					
	Private			Public			Private			Public			Private			Public		
	1998 %	2014 %	Change	1998 %	2014 %	Change	1998 %	2014 %	Change	1998 %	2014 %	Change	1998 %	2014 %	Change	1998 %	2014 %	Change
Albert Park	7.06	8.00	0.94	5.18	5.65	0.47	48.94	50.35	1.41	14.82	14.59	-0.24	17.18	14.82	-2.35	6.82	6.59	-0.24
Allenby Gardens	8.47	8.24	-0.24	7.76	9.41	1.65	34.59	39.29	4.71	16.47	16.71	0.24	22.59	18.12	-4.47	8.47	6.59	-1.88
Athol Park	5.18	5.18	0.00	2.59	2.82	0.24	46.35	52.71	6.35	13.18	14.82	1.65	24.94	18.59	-6.35	5.88	4.00	-1.88
Beverley	10.12	9.88	-0.24	3.53	2.82	-0.71	52.24	51.06	-1.18	12.47	12.71	0.24	15.76	16.94	1.18	2.59	3.06	0.47
Bowden	7.76	8.47	0.71	5.18	5.41	0.24	49.41	45.65	-3.76	20.00	19.76	-0.24	12.00	15.06	3.06	5.41	5.41	0.00
Brompton	8.94	10.12	1.18	1.41	4.71	3.29	48.24	55.29	7.06	16.24	16.47	0.24	17.41	9.18	-8.24	7.53	4.00	-3.53
Cheltenham	12.71	9.65	-3.06	4.94	5.18	0.24	47.06	50.82	3.76	15.29	15.06	-0.24	16.00	15.29	-0.71	4.00	4.00	0.00
Croydon	12.71	14.12	1.41	6.59	6.59	0.00	40.94	42.12	1.18	18.35	17.65	-0.71	17.65	15.06	-2.59	3.76	4.47	0.71
Devon Park	12.47	12.94	0.47	2.59	5.41	2.82	43.06	43.29	0.24	25.65	22.82	-2.82	12.94	12.24	-0.71	3.29	3.29	0.00
Findon	10.12	2.35	-7.76	1.65	0.71	-0.94	44.24	50.35	6.12	15.06	15.76	0.71	20.47	15.29	-5.18	6.59	6.12	-0.47
Flinders Park	12.24	10.12	-2.12	8.47	8.24	-0.24	32.47	40.00	7.53	12.47	14.12	1.65	21.88	16.47	-5.41	8.47	6.59	-1.88
Fulham Gardens	7.29	8.00	0.71	3.53	4.24	0.71	43.76	47.06	3.29	15.53	16.00	0.47	20.24	16.24	-4.00	9.18	8.00	-1.18
Grange	15.29	13.88	-1.41	4.00	5.18	1.18	22.35	27.53	5.18	9.41	9.41	0.00	19.76	14.35	-5.41	5.41	4.24	-1.18
Hendon	7.06	5.41	-1.65	4.00	3.06	-0.94	48.71	55.76	7.06	16.71	16.47	-0.24	19.76	14.35	-5.41	3.53	4.94	1.41
Henley Beach	11.76	8.71	-3.06	5.88	4.71	-1.18	32.94	36.94	4.00	13.88	16.94	3.06	13.88	12.94	-0.94	9.88	8.24	-1.65
Henley Beach South	13.18	10.35	-2.82	7.29	8.71	1.41	26.59	32.47	5.88	15.53	16.00	0.47	16.94	13.88	-3.06	9.18	7.76	-1.41
Hindmarsh	6.59	3.76	-2.82	4.94	8.00	3.06	53.88	59.76	5.88	21.18	20.24	-0.94	5.88	2.82	-3.06	5.41	3.53	-1.88
Kidman Park	10.35	8.94	-1.41	5.41	6.35	0.94	39.76	47.06	7.29	12.00	11.76	-0.24	19.06	13.88	-5.18	8.24	7.53	-0.71
Kilkenny	7.76	7.06	-0.71	1.65	1.65	0.00	58.59	64.24	5.65	16.00	15.53	-0.47	13.41	8.47	-4.94	1.65	2.12	0.47
Ovingham	22.59	18.59	-4.00	4.71	6.82	2.12	34.82	39.29	4.47	24.47	23.06	-1.41	8.00	7.53	-0.47	5.41	4.71	-0.71
Pennington	12.47	11.29	-1.18	2.82	3.29	0.47	41.41	47.76	6.35	14.12	14.35	0.24	20.94	15.76	-5.18	6.82	6.12	-0.71

	TREE COVER						IMPERVIOUS COVER						PLANTABLE SPACE COVER					
	Private			Public			Private			Public			Private			Public		
	1998 %	2014 %	Change	1998 %	2014 %	Change	1998 %	2014 %	Change	1998 %	2014 %	Change	1998 %	2014 %	Change	1998 %	2014 %	Change
Renown Park	9.88	11.53	1.65	7.29	9.18	1.88	36.24	38.12	1.88	18.35	17.65	-0.71	15.29	11.76	-3.53	6.12	5.18	-0.94
Ridleyton	11.53	10.35	-1.18	3.06	5.18	2.12	42.82	50.35	7.53	15.06	14.82	-0.24	17.41	11.06	-6.35	8.00	7.06	-0.94
Royal Park	9.41	7.29	-2.12	4.94	3.76	-1.18	40.47	47.29	6.82	17.88	19.53	1.65	19.06	14.35	-4.71	6.35	5.88	-0.47
Seaton	15.06	11.76	-3.29	2.59	3.76	1.18	32.47	36.47	4.00	13.65	13.41	-0.24	20.00	19.76	-0.24	5.18	4.00	-1.18
Semaphore Park	8.71	11.06	2.35	5.18	5.88	0.71	29.41	33.65	4.24	14.35	14.59	0.24	17.41	10.82	-6.59	6.82	5.65	-1.18
St Clair	2.12	0.47	-1.65	5.41	0.71	-4.71	14.82	25.41	10.59	13.88	24.00	10.12	18.12	15.53	-2.59	29.65	18.12	-11.53
Tennyson	5.18	5.18	0.00	1.65	2.12	0.47	17.88	21.65	3.76	10.59	11.06	0.47	10.59	6.59	-4.00	7.53	6.59	-0.94
Welland	10.12	9.41	-0.71	3.06	4.00	0.94	57.88	60.00	2.12	9.18	9.65	0.47	15.76	14.35	-1.41	3.53	2.12	-1.41
West Beach	10.59	8.47	-2.12	4.00	5.65	1.65	26.59	33.88	7.29	13.18	14.12	0.94	19.29	13.41	-5.88	8.47	6.59	-1.88
West Croydon	9.65	9.88	0.24	6.12	5.88	-0.24	43.06	47.29	4.24	19.06	18.59	-0.47	18.35	13.88	-4.47	1.88	2.59	0.71
West Hindmarsh	14.12	10.82	-3.29	5.65	6.35	0.71	40.94	45.18	4.24	18.59	18.35	-0.24	15.29	14.35	-0.94	4.71	4.47	-0.24
West Lakes	7.53	7.29	-0.24	4.00	2.59	-1.41	29.88	31.06	1.18	16.94	17.88	0.94	10.82	9.18	-1.65	9.65	10.12	0.47
West Lakes Shore	7.29	5.88	-1.41	4.24	4.47	0.24	27.29	31.29	4.00	13.88	13.65	-0.24	13.88	11.29	-2.59	8.71	9.18	0.47
Woodville	10.82	10.12	-0.71	4.47	4.71	0.24	46.12	50.12	4.00	20.24	19.53	-0.71	15.76	12.47	-3.29	2.59	3.06	0.47
Woodville North	10.12	6.12	-4.00	3.76	2.35	-1.41	48.00	59.06	11.06	12.00	12.71	0.71	22.35	15.29	-7.06	2.35	3.06	0.71
Woodville Park	13.41	12.24	-1.18	4.94	5.65	0.71	43.53	46.35	2.82	13.65	13.88	0.24	19.76	18.12	-1.65	4.71	3.76	-0.94
Woodville South	15.53	13.41	-2.12	4.00	3.29	-0.71	39.53	45.41	5.88	15.29	15.29	0.00	16.94	13.41	-3.53	3.76	4.47	0.71
Woodville West	10.35	0.94	-9.41	5.65	3.53	-2.12	36.94	39.76	2.82	15.76	16.00	0.24	24.94	24.47	-0.47	6.12	5.41	-0.71

Implications of land cover change by tenure

Understanding the contribution of land cover changes on public and private land helps to further refine relevant Council actions that will help to achieve greening and tree planting objectives across the City as a whole.

For example, using the tenure-specific analysis to build on the finding from the suburb-level assessment, we conclude that:

- St Clair's land cover change between 1998 and 2014 is perhaps the most dramatic and interesting of all the suburbs, with the greatest increase in impervious cover and decrease in plantable space observed at the suburb-level. Whilst impervious cover increased to similar extents on private and public lands (10.59% and 10.12%, respectively), the decrease in plantable space occurred predominantly on public rather than private lands (11.53% and 2.59%). It is of further interest to note that, at the suburb-scale, St Clair experienced a non-significant loss of tree cover between 1998 and 2014, yet the loss of cover on public land was the greatest of all suburbs; at more than twice the amount of public tree loss in Woodville West, which was the suburb with the second highest loss on public land (4.71% and 2.12%, respectively). This is indicative of the St Clair's large scale conversion of the previously dominant horse racing track to residential development – a process which is still underway, meaning that impervious cover may be expected to increase further over the coming years.
    - The extensive conversion occurring in St Clair presents opportunities for integrating novel green infrastructure plantings and elements at the development stage, rather than being limited to retrofitting, which is what often occurs in established suburbs. In addition to a focussed residential education and incentives campaign for new residents, St Clair also provides the greatest opportunities for increasing planting and green infrastructure elements in the public space wending its way through the developments;
- Woodville North's decrease in percent tree cover and increase in impervious cover occurred primarily on private land, which implies urban in-fill as a process driving tree loss. The percent plantable space in this suburb also occurs primarily on private land.
    - To help improve tree cover across the City, therefore, Council may target suburbs such as Woodville North and others with similar land-cover trends for incentives programs which promote tree retention and planting on private property. Revision of development policies may also be considered to incorporate better tree retention and planting in subdivisions and developments;
- Brompton's increase in percent tree cover was driven by increases on public and private land, though primarily on public land, which may reflect Council's street tree planting efforts. Whilst percent plantable space also decreased on public land, again reflecting potential planting programs, the greatest loss of plantable spaces occurred on private land. At the same time, percent impervious increased primarily on private land. This suggests that although tree cover on public land increased, more urban in-fill than tree planting is occurring.
    - Plantable opportunities occur on both private and public land, though a high amount of urban in-fill on private land is also likely. As tree cover has increased on both public and private land, Council may target suburbs such as Brompton for

additional planting programs on public land, coupled with education campaigns aimed at promoting the benefits of retaining and planting trees on public land;

- Bowden's increase in plantable space occurred entirely on private land and the decrease in impervious cover almost entirely on private land. This suggests a suburb in transition, and based on other common trends across the City is likely to be indicative of the process of urban in-fill in progress.
    - Given the likely dynamic status of this suburb, Council may target this and other similar suburbs for incentive and education programs which encourage planting on private land. As some plantable space also occurs on public land, undertaking planting programs in such suburbs will help to increase overall canopy cover in the City, as well as providing a leading example to private property owners.

4 Discussion

4.1 Key findings

Trees are an important component of the urban matrix, not only contributing to a city's character and liveability and helping to create a unique "sense of place", but also providing a suite of beneficial services for the environment, biodiversity, and people. A key challenge for urban land managers is how to maintain and increase tree cover given increasing demands for space and resources to support divergent land-uses, such as urban development. Further complicating this challenge is that much of the land in urban areas is often privately owned, which limits the direct influence that public greening/planting programs can have across the City area as a whole.

Being able to effectively and efficiently measure land cover change over time and across tenures can provide urban land managers with the critical tools and information necessary to monitor the success of greening objectives and prioritise locations for targeting different programs and actions to achieve the best outcome across the City. The i-Tree Canopy software was used in this project to measure land cover (including tree/canopy) cover at different spatial and temporal scales across the City of Charles Sturt. This software provides consistent, user-friendly and transparent approach to measuring and monitoring land cover change.

One of the key findings from this assessment was that tree cover across the City (i.e. both public and private land) has declined overall since 1998. This has occurred despite substantial Council tree planting efforts, particularly between 2002-2007 when 5,312 street trees were planted (comparatively, 10% fewer trees were planted between 2008-2014) (City of Charles Sturt, 2014). Tree clearing on private land may explain the overall decline in tree cover across the City, with loss of city-wide tree cover on private land being greater than gain of tree cover on public land. This explanation may be further supported by the trends in different categories of "tree cover" assessed. For example, within public land, 'tree over impervious surfaces' was the primary contributor to overall tree cover increase, which may reflect planting efforts as well as the growth of existing street tree canopies. On private land, however, 'tree over pervious surfaces' was the driver of overall tree cover loss, whilst 'tree over pervious surface' increased slightly. The process driving the loss of trees on private land is likely urban in-fill, with this assumption supported by a concomitant increase in impervious surfaces on private land, driven primarily by building cover.

Such findings have substantial implications for ongoing Council greening actions, but understanding nuances at the suburb-scale will be important for prioritising the type and location of such actions. For example, based on tree cover alone, Tennyson and St Clair may be targeted for planting programs, having the lowest current percent tree cover of all suburbs. However, Tennyson also has the highest percent beach cover which will limit the plantable space for tree planting. St Clair, however, also has the highest percent plantable space and so likely represents a priority target. Whether these opportunities occur on public or private land though will influence Council's direct action ability.

In addition to suburb-scale trends, therefore, management decisions and actions will be further informed by tenure-scale patterns. For instance, at the suburb-scale St Clair,

Woodville West and Allenby Gardens present the greatest opportunities for planting. However, in Woodville West and Allenby Gardens, this space occurs primarily on private land, thereby limiting the ability to implement Council planting programs. Comparatively, more plantable space in St Clair occurs on public land thereby providing the best opportunity for implementing Council planting programs. Interestingly, West Lakes has the next highest amount of plantable space on public land, and with just under 10% tree cover, also presents a key Council planting target. Such assessments highlight the importance of considering multiple land cover categories (e.g. not just the amount of tree cover) at a tenure-scale.

Similarly, community education and incentives programs, rather than Council planting programs, may be targeted in suburbs such as Woodville West and Findon, which both experienced the greatest decline in percent tree cover on private land between 1998 and 2014.

Additional demographic and climatic information such as where vulnerable members of the community or thermal hotspots occur may also be of use for influencing and prioritising decisions and actions. For example, Council may prioritise tree planting programs by identifying spatial correlations among the following metrics: low tree cover suburbs, high plantable space on public land, concentrations of vulnerable community members (e.g. elderly or low socio-economic classes), and thermal hotspots. Doing so will have overall benefits for the City as a whole, as well as supporting the City's most vulnerable areas and communities. The collection and analyses of demographic and climatic data were beyond the scope of this project.

4.2 Comparison with pilot study findings

Despite the pilot study reporting on only three suburbs, compared to the 39 in this assessment, there was general corroboration between the findings, with both studies reporting an overall increasing trend in tree cover on public land over time, but an overall decline in tree cover across combined tenures, being driven by declining tree cover on private land. Similarly, the pilot study also showed variation in land cover change trends among suburbs. Such findings in this assessment and the pilot study suggest that whilst increasing tree planting programs on public land will facilitate greening objectives, the solution is more complex and will require a combination of approaches, with their application best informed by considering land cover trends specific to each suburb.

However, for each suburb specifically, there were substantial inconsistencies in the land cover change trends at suburb scale and tenure-scale. In particular, this assessment reported tree cover loss in each tenure type in each of the three suburbs, whereas the pilot study reported increases, with the exception of private land in Woodville West (Table 4). Similarly, plantable space in Findon was found in this assessment to decline in both tenures, whereas the pilot study reported increases.

The inconsistencies may have occurred due to a combination of reasons:

- differences between assessors' interpretation of land cover, with assessors being different between the pilot and current assessment;
- the approach applied in the pilot study which required the assessor to judge tenure (e.g. tree on private or public land) at the time of point classification, rather than applying the

more rigorous approach of analysing tenure post-land cover classification using a GIS spatial overlay, as was done in this assessment;

- the different land cover categories used, with the pilot study using only four land cover categories, whereas this assessment applied twelve which allowed for more realistic representation of plantable space in the City; or,
- the difference between the date of satellite imagery used to assess "current" land cover for these three suburbs, with the pilot study reporting that 2014 satellite imagery was used, whereas 2016 imagery was used in the current assessment.

These inconsistencies highlight the importance of maintaining consistent approaches to potential future assessments.

Table 4. Tenure-specific, suburb-scale land cover change comparisons between this assessment and the pilot study for Findon, St Clair, and Woodville West.

	Change in Tree Cover		Change in Impervious Cover		Change in Plantable Space Cover	
	Private	Public	Private	Public	Private	Public
This assessment						
Findon	-7.76%	-0.94%	6.12%	0.71%	-5.18%	-0.47%
St Clair	-1.65%	-4.71%	10.59%	10.12%	-2.59%	-11.53%
Woodville West	-9.41%	-2.12%	2.82%	0.24%	-0.47%	-0.71%
Pilot Study^						
Findon	4.2%	2.01%	13.5%	0.6%	-5.31%	-6.6%
St Clair	0.2%	3.4%	4.2%	10.2%	24.6%	7%
Woodville West	-5.2%	0.2%	9.6%	-1%	-2.8%	-0.8%

^ Derived from Charleton (2014)

4.3 Implications of tree declines

The findings from this project serve to highlight that tree/canopy cover in the City of Charles Sturt are declining despite Council's best efforts to increase cover through dedicated planting programs on public land. Such declines in tree/canopy cover present a major challenge for Council in meeting future goals around recreation and open space and climate change adaptation, especially given projected rates and extents of on-going urban in-fill on private land. Mitigating future tree loss, and moving towards overall canopy cover gain across the City will require complimentary greening actions on public and private land.

The implications of on-going declining tree cover will be wide and varied, with substantial negative impacts on the liveability, prosperity, and long-term resilience of the City. Specific examples, include:

- lower air quality (e.g. dust and pollutants), which will impact human health and well-being, particularly vulnerable members of the community (e.g. very young or elderly, and those with compromised respiratory systems);

- hotter average day and night temperatures, contributing further to the urban heat island effect, which will itself be exacerbated by climate change-induced temperature rises. Higher temperatures will impact negatively on: the health and well-being of community members; the wear and maintenance of built assets (e.g. roads); water availability; building energy efficiency; and, the survival and maintenance costs associated with existing green infrastructure elements;
- decreased shading, which will lead to people being less inclined to spend leisure time outdoors in parks and gardens and so negatively influence community connectedness and health and well-being. Where shading is lost near buildings, increased energy costs associated with cooling the building may occur;
- increased winds, with this exacerbating decreased air quality and community health, as well as decreasing the liveability and attractiveness of the City;
- increase localised flooding and destabilised waterway/coastal banks and margins, which will directly impact infrastructure and communities and decrease water quality;
- decreased biodiversity which will compromise the functioning of whole ecosystems, and potentially have flow-on effects to other systems reliant on natural ecosystem functioning (e.g. nearby horticultural systems may be impacted if natural pest predators and pollinators no longer occur in the region); and
- decreased amenity, which will decrease property values and the desire for people to live, work and visit the City, with flow-on effects to local economic prosperity and crime rates.

4.4 Future opportunities

The information derived from this project will likely have immediate applications for informing management decisions and target-setting. A number of additional opportunities exist to further inform decisions and prioritise actions, such as:

- identifying and spatially mapping key demographic indicators that may benefit from increased tree plantings, such as: socio-economic classes, age classes, health classes;
    - such information could be used to investigate spatial congruence with planting opportunities;
- identifying and spatially mapping key climate indicators that may benefit from increased tree plantings, such as thermal hotspots
    - such information could be used to investigate spatial congruence with planting opportunities; and
- valuing the urban forest as an urban asset;
    - using i-Tree Eco, the value of certain ecosystem services provided by urban trees can be calculated which can then be used to view trees as urban assets and justify the business-case for trees.

5 References

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6 Attachments

Attachment A Notes on statistical analysis.

Attachment B. Number of points and equivalent percent cover for each land cover category in each time period and tenure relative to the City of Charles Sturt.

Attachment C. Number of points and equivalent percent cover for each land cover category in each time period relative to suburb.

Attachment D. Number of points and equivalent percent cover for each land cover category in each tenure type in 2014 relative to suburb

Attachment E. Number of points and equivalent percent cover for each land cover category in each tenure type in 2008 relative to suburb

Attachment F. Number of points and equivalent percent cover for each land cover category in each tenure type in 1998 relative to suburb

Attachment A. Notes on statistical analysis

A p-value, or probability value, is one output from a t-test (i.e. any statistical hypothesis test) which indicates whether the differences between data being compared are occurring due to chance (i.e. not significantly different) or are a real phenomenon (i.e. is significantly different). The critical alpha value sets the standard to which the p-value is compared and is usually set to 0.05. Therefore, a p-value less than or equal to 0.05 indicates the observed difference between the data is so unusual that it would only have happened by chance, at most, 5% of the time and so the difference is considered statistically significant. If a p-value is greater than 0.05, this indicates that the observed difference between data could have happened by chance more than 5% of the time and so the difference is considered statistically insignificant.

Comparing p-values can indicate relative significance between multiple significance tests. For example, a p-value of 0.001 indicates a more statistically significant difference than a p-value of 0.01. However, other factors are also generally considered in statistics which influence how significance tests are interpreted, such as autocorrelation and effect size.

Autocorrelation refers to the influence that different values have on each other. For example, in this project, points would be considered to be spatially autocorrelated if their proximity to each other influenced the type of land cover category of each point. Detailed statistical analyses were beyond the scope of this project though and so for the purposes of the broad level indicative statistical analyses conducted here, we assumed no spatial or temporal autocorrelation between points. Meaning that it was assumed that the data points are independent and land-use category of one point does not influence the land-use category of nearby points in the same time period or the same point across different time periods.

Effect size can help to interpret substantive significance, rather than purely statistical significance. The statistical analyses in this report were intended only to provide an indication of whether land cover change was likely to be statistically significance or not. Accordingly, for the purposes of these analyses, we did not report on effect sizes.

Furthermore, when interpreting statistical significance here, it is important to note the data sets involved in the statistical analyses as the statistical significance reported is relevant only to the data points involved in the analysis. For example, a comparison of land cover change within a particular suburb may report on the statistical significance of that particular suburb's data sets in two time periods. This, however, does not directly relate to changes occurring in other suburbs. Accordingly, a change in one suburb may be found to be statistically significant, whilst a similar quantified change in another suburb may not be statistically significant.

Attachment A. Number of points and equivalent percent cover (%) for each land cover category in each time period relative to the 16,575 points sampled across the City of Charles Sturt.

LAND COVER CATEGORY		NUMBER OF POINTS ACROSS CCST									PERCENT COVER ACROSS CCST (%)								
		1998			2008			2014			1998			2008			2014		
		Total	Private	Public	Total	Private	Public	Total	Private	Public	Total	Private	Public	Total	Private	Public	Total	Private	Public
Impervious	Impervious - building	4350	4271	79	4602	4541	61	4859	4807	52	26.24	25.77	0.48	27.76	27.40	0.37	29.32	29.00	0.31
	Impervious - other	3063	2234	829	3143	2313	830	3332	2439	893	18.48	13.48	5.00	18.96	13.95	5.01	20.10	14.71	5.39
	Impervious - road	1744	58	1686	1741	62	1679	1780	69	1711	10.52	0.35	10.17	10.50	0.37	10.13	10.74	0.42	10.32
Tree	Tree - per	1815	1349	466	1778	1259	519	1600	1112	488	10.95	8.14	2.81	10.73	7.60	3.13	9.65	6.71	2.94
	Tree - imp	640	366	274	792	469	323	767	430	337	3.86	2.21	1.65	4.78	2.83	1.95	4.63	2.59	2.03
Plantable space	Bare ground	755	551	204	1566	1055	511	1419	992	427	4.56	3.32	1.23	9.45	6.37	3.08	8.56	5.98	2.58
	Grass - other	3161	2287	874	1938	1430	508	1794	1292	502	19.07	13.80	5.27	11.69	8.63	3.06	10.82	7.79	3.03
Other	Grass - sporting	439	264	175	411	244	167	387	231	156	2.65	1.59	1.06	2.48	1.47	1.01	2.33	1.39	0.94
	Wetland veg	9	0	9	10	1	9	22	1	21	0.05	0.00	0.05	0.06	0.01	0.05	0.13	0.01	0.13
	Water	152	1	151	149	2	147	165	2	163	0.92	0.01	0.91	0.90	0.01	0.89	1.00	0.01	0.98
	Beach	306	9	297	295	10	285	308	11	297	1.85	0.05	1.79	1.78	0.06	1.72	1.86	0.07	1.79
	Dune vegetation	141	1	140	150	5	145	142	5	137	0.85	0.01	0.84	0.90	0.03	0.87	0.86	0.03	0.83

Attachment B. Number of points and equivalent percent cover (%) for each land cover category in each time period relative to the 425 points sampled in each suburb. Land cover categories are abbreviated as follows: ImpBld = impervious-building; ImpOth = impervious-other; ImpRd = impervious-road; TrPer = tree-pervious; TrImp = tree-impervious; BG = bare ground; GrOth = grass-other; GrSpt = grass sporting; WV = wetland vegetation; W = water; B = beach; DV = dune vegetation.

		NUMBER OF POINTS PER SUBURB													PERCENT COVER PER SUBURB (%)												
		Impervious			Tree		Plantable Space		Other						Impervious			Tree		Plantable Space		Other					
Suburb	Year	ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV		ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV	
Albert Park	1998	138	92	41	33	19	22	80	0	0	0	0	0		32.47	21.65	9.65	7.76	4.47	5.18	18.82	0.00	0.00	0.00	0.00	0.00	
	2008	139	91	40	42	19	44	50	0	0	0	0	0		32.71	21.41	9.41	9.88	4.47	10.35	11.76	0.00	0.00	0.00	0.00	0.00	
	2014	143	93	40	35	23	41	50	0	0	0	0	0		33.65	21.88	9.41	8.24	5.41	9.65	11.76	0.00	0.00	0.00	0.00	0.00	
Allenby Gardens	1998	109	56	52	48	21	65	67	6	1	0	0	0		25.65	13.18	12.24	11.29	4.94	15.29	15.76	1.41	0.24	0.00	0.00	0.00	
	2008	125	57	51	66	24	44	51	6	1	0	0	0		29.41	13.41	12.00	15.53	5.65	10.35	12.00	1.41	0.24	0.00	0.00	0.00	
	2014	130	57	51	53	22	36	69	6	1	0	0	0		30.59	13.41	12.00	12.47	5.18	8.47	16.24	1.41	0.24	0.00	0.00	0.00	
Athol Park	1998	114	104	35	27	6	22	109	8	0	0	0	0		26.82	24.47	8.24	6.35	1.41	5.18	25.65	1.88	0.00	0.00	0.00	0.00	
	2008	101	94	33	32	17	101	39	8	0	0	0	0		23.76	22.12	7.76	7.53	4.00	23.76	9.18	1.88	0.00	0.00	0.00	0.00	
	2014	138	114	35	24	10	52	44	8	0	0	0	0		32.47	26.82	8.24	5.65	2.35	12.24	10.35	1.88	0.00	0.00	0.00	0.00	
Beverley	1998	129	110	36	37	21	26	52	14	0	0	0	0		30.35	25.88	8.47	8.71	4.94	6.12	12.24	3.29	0.00	0.00	0.00	0.00	
	2008	131	103	34	40	19	46	37	15	0	0	0	0		30.82	24.24	8.00	9.41	4.47	10.82	8.71	3.53	0.00	0.00	0.00	0.00	
	2014	124	113	34	37	17	54	31	15	0	0	0	0		29.18	26.59	8.00	8.71	4.00	12.71	7.29	3.53	0.00	0.00	0.00	0.00	
Bowden	1998	149	98	48	37	18	30	44	1	0	0	0	0		35.06	23.06	11.29	8.71	4.24	7.06	10.35	0.24	0.00	0.00	0.00	0.00	
	2008	155	103	47	44	22	37	15	2	0	0	0	0		36.47	24.24	11.06	10.35	5.18	8.71	3.53	0.47	0.00	0.00	0.00	0.00	
	2014	132	97	49	36	23	69	18	1	0	0	0	0		31.06	22.82	11.53	8.47	5.41	16.24	4.24	0.24	0.00	0.00	0.00	0.00	
Brompton	1998	128	103	43	30	14	39	67	1	0	0	0	0		30.12	24.24	10.12	7.06	3.29	9.18	15.76	0.24	0.00	0.00	0.00	0.00	
	2008	133	92	44	35	33	55	32	1	0	0	0	0		31.29	21.65	10.35	8.24	7.76	12.94	7.53	0.24	0.00	0.00	0.00	0.00	
	2014	156	99	50	31	32	27	29	1	0	0	0	0		36.71	23.29	11.76	7.29	7.53	6.35	6.82	0.24	0.00	0.00	0.00	0.00	

Suburb	Year	NUMBER OF POINTS PER SUBURB													PERCENT COVER PER SUBURB (%)										
		Impervious			Tree		Plantable Space		Other						Impervious			Tree		Plantable Space		Other				
		ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV		ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV
Cheltenham	1998	124	98	43	62	13	18	67	0	0	0	0	0		29.18	23.06	10.12	14.59	3.06	4.24	15.76	0.00	0.00	0.00	0.00	0.00
	2008	132	106	43	45	17	34	48	0	0	0	0	0		31.06	24.94	10.12	10.59	4.00	8.00	11.29	0.00	0.00	0.00	0.00	0.00
	2014	134	104	42	43	20	34	48	0	0	0	0	0		31.53	24.47	9.88	10.12	4.71	8.00	11.29	0.00	0.00	0.00	0.00	0.00
Croydon	1998	116	86	50	48	34	24	67	0	0	0	0	0		27.29	20.24	11.76	11.29	8.00	5.65	15.76	0.00	0.00	0.00	0.00	0.00
	2008	114	82	49	49	41	44	46	0	0	0	0	0		26.82	19.29	11.53	11.53	9.65	10.35	10.82	0.00	0.00	0.00	0.00	0.00
	2014	119	87	48	49	39	49	34	0	0	0	0	0		28.00	20.47	11.29	11.53	9.18	11.53	8.00	0.00	0.00	0.00	0.00	0.00
Devon Park	1998	126	86	80	48	16	14	55	0	0	0	0	0		29.65	20.24	18.82	11.29	3.76	3.29	12.94	0.00	0.00	0.00	0.00	0.00
	2008	128	69	72	55	38	35	28	0	0	0	0	0		30.12	16.24	16.94	12.94	8.94	8.24	6.59	0.00	0.00	0.00	0.00	0.00
	2014	131	78	72	43	35	34	32	0	0	0	0	0		30.82	18.35	16.94	10.12	8.24	8.00	7.53	0.00	0.00	0.00	0.00	0.00
Findon	1998	123	87	42	41	9	30	85	8	0	0	0	0		28.94	20.47	9.88	9.65	2.12	7.06	20.00	1.88	0.00	0.00	0.00	0.00
	2008	96	61	34	64	24	34	95	14	1	2	0	0		32.00	19.06	10.35	10.12	3.06	13.65	10.35	1.41	0.00	0.00	0.00	0.00
	2014	127	83	42	37	9	15	110	0	0	2	0	0		34.59	21.18	10.35	8.00	3.06	13.65	7.76	1.41	0.00	0.00	0.00	0.00
Flinders Park	1998	96	61	34	64	24	34	95	14	1	2	0	0		22.59	14.35	8.00	15.06	5.65	8.00	22.35	3.29	0.24	0.47	0.00	0.00
	2008	105	78	38	72	16	34	63	14	2	3	0	0		24.71	18.35	8.94	16.94	3.76	8.00	14.82	3.29	0.47	0.71	0.00	0.00
	2014	113	78	39	63	15	37	61	14	2	3	0	0		26.59	18.35	9.18	14.82	3.53	8.71	14.35	3.29	0.47	0.71	0.00	0.00
Fulham Gardens	1998	127	83	42	37	9	15	110	0	0	2	0	0		29.88	19.53	9.88	8.71	2.12	3.53	25.88	0.00	0.00	0.47	0.00	0.00
	2008	146	77	43	45	12	20	80	0	0	2	0	0		34.35	18.12	10.12	10.59	2.82	4.71	18.82	0.00	0.00	0.47	0.00	0.00
	2014	145	80	43	38	14	28	75	0	0	2	0	0		34.12	18.82	10.12	8.94	3.29	6.59	17.65	0.00	0.00	0.47	0.00	0.00
Grange	1998	65	40	30	69	13	10	97	74	1	3	17	6		15.29	9.41	7.06	16.24	3.06	2.35	22.82	17.41	0.24	0.71	4.00	1.41
	2008	79	47	29	71	16	30	45	82	1	2	17	6		18.59	11.06	6.82	16.71	3.76	7.06	10.59	19.29	0.24	0.47	4.00	1.41
	2014	84	43	30	65	16	38	41	82	1	2	17	6		19.76	10.12	7.06	15.29	3.76	8.94	9.65	19.29	0.24	0.47	4.00	1.41

Suburb	Year	NUMBER OF POINTS PER SUBURB													PERCENT COVER PER SUBURB (%)										
		Impervious			Tree		Plantable Space		Other						Impervious			Tree		Plantable Space		Other				
		ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV		ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV
Hendon	1998	123	89	66	36	11	15	84	0	0	1	0	0		28.94	20.94	15.53	8.47	2.59	3.53	19.76	0.00	0.00	0.24	0.00	0.00
	2008	145	89	66	29	9	38	49	0	0	0	0	0		34.12	20.94	15.53	6.82	2.12	8.94	11.53	0.00	0.00	0.00	0.00	0.00
	2014	149	92	66	25	11	49	33	0	0	0	0	0		35.06	21.65	15.53	5.88	2.59	11.53	7.76	0.00	0.00	0.00	0.00	0.00
Henley Beach	1998	106	52	41	53	22	5	96	15	0	0	34	1		24.94	12.24	9.65	12.47	5.18	1.18	22.59	3.53	0.00	0.00	8.00	0.24
	2008	116	61	43	54	18	22	62	15	0	0	30	4		27.29	14.35	10.12	12.71	4.24	5.18	14.59	3.53	0.00	0.00	7.06	0.94
	2014	121	65	43	40	17	37	53	15	0	0	30	4		28.47	15.29	10.12	9.41	4.00	8.71	12.47	3.53	0.00	0.00	7.06	0.94
Henley Beach South	1998	83	51	45	66	21	7	104	8	0	3	30	7		19.53	12.00	10.59	15.53	4.94	1.65	24.47	1.88	0.00	0.71	7.06	1.65
	2008	96	55	46	64	18	33	67	8	0	3	25	10		22.59	12.94	10.82	15.06	4.24	7.76	15.76	1.88	0.00	0.71	5.88	2.35
	2014	99	64	43	60	21	35	57	8	0	3	30	5		23.29	15.06	10.12	14.12	4.94	8.24	13.41	1.88	0.00	0.71	7.06	1.18
Hindmarsh	1998	141	117	61	25	24	20	28	5	3	1	0	0		33.18	27.53	14.35	5.88	5.65	4.71	6.59	1.18	0.71	0.24	0.00	0.00
	2008	147	120	58	28	22	27	15	5	1	2	0	0		34.59	28.24	13.65	6.59	5.18	6.35	3.53	1.18	0.24	0.47	0.00	0.00
	2014	161	121	58	25	25	20	7	5	1	2	0	0		37.88	28.47	13.65	5.88	5.88	4.71	1.65	1.18	0.24	0.47	0.00	0.00
Kidman Park	1998	110	78	32	51	16	21	95	20	0	2	0	0		25.88	18.35	7.53	12.00	3.76	4.94	22.35	4.71	0.00	0.47	0.00	0.00
	2008	127	79	30	45	23	30	72	17	0	2	0	0		29.88	18.59	7.06	10.59	5.41	7.06	16.94	4.00	0.00	0.47	0.00	0.00
	2014	135	83	32	50	15	32	59	17	0	2	0	0		31.76	19.53	7.53	11.76	3.53	7.53	13.88	4.00	0.00	0.47	0.00	0.00
Kilkenny	1998	147	111	59	28	12	17	47	4	0	0	0	0		34.59	26.12	13.88	6.59	2.82	4.00	11.06	0.94	0.00	0.00	0.00	0.00
	2008	149	105	58	23	18	36	32	4	0	0	0	0		35.06	24.71	13.65	5.41	4.24	8.47	7.53	0.94	0.00	0.00	0.00	0.00
	2014	159	120	60	21	16	24	21	4	0	0	0	0		37.41	28.24	14.12	4.94	3.76	5.65	4.94	0.94	0.00	0.00	0.00	0.00
Ovingham	1998	109	69	74	91	25	15	42	0	0	0	0	0		25.65	16.24	17.41	21.41	5.88	3.53	9.88	0.00	0.00	0.00	0.00	0.00
	2008	112	71	70	71	42	39	20	0	0	0	0	0		26.35	16.71	16.47	16.71	9.88	9.18	4.71	0.00	0.00	0.00	0.00	0.00
	2014	120	72	73	70	38	40	12	0	0	0	0	0		28.24	16.94	17.18	16.47	8.94	9.41	2.82	0.00	0.00	0.00	0.00	0.00

Suburb	Year	NUMBER OF POINTS PER SUBURB													PERCENT COVER PER SUBURB (%)										
		Impervious			Tree		Plantable Space		Other						Impervious			Tree		Plantable Space		Other				
		ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV		ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV
Pennington	1998	99	92	45	50	15	18	100	6	0	0	0	0		23.29	21.65	10.59	11.76	3.53	4.24	23.53	1.41	0.00	0.00	0.00	0.00
	2008	108	101	46	48	16	34	66	6	0	0	0	0		25.41	23.76	10.82	11.29	3.76	8.00	15.53	1.41	0.00	0.00	0.00	0.00
	2014	117	103	44	45	17	42	51	6	0	0	0	0		27.53	24.24	10.35	10.59	4.00	9.88	12.00	1.41	0.00	0.00	0.00	0.00
Renown Park	1998	106	74	52	56	17	20	71	29	0	0	0	0		24.94	17.41	12.24	13.18	4.00	4.71	16.71	6.82	0.00	0.00	0.00	0.00
	2008	103	73	53	72	22	34	40	28	0	0	0	0		24.24	17.18	12.47	16.94	5.18	8.00	9.41	6.59	0.00	0.00	0.00	0.00
	2014	109	77	51	67	21	38	34	28	0	0	0	0		25.65	18.12	12.00	15.76	4.94	8.94	8.00	6.59	0.00	0.00	0.00	0.00
Ridleyton	1998	114	95	37	38	24	24	84	9	0	0	0	0		26.82	22.35	8.71	8.94	5.65	5.65	19.76	2.12	0.00	0.00	0.00	0.00
	2008	121	101	43	33	27	44	51	5	0	0	0	0		28.47	23.76	10.12	7.76	6.35	10.35	12.00	1.18	0.00	0.00	0.00	0.00
	2014	129	110	38	36	30	43	34	5	0	0	0	0		30.35	25.88	8.94	8.47	7.06	10.12	8.00	1.18	0.00	0.00	0.00	0.00
Royal Park	1998	118	70	60	44	17	17	91	8	0	0	0	0		27.76	16.47	14.12	10.35	4.00	4.00	21.41	1.88	0.00	0.00	0.00	0.00
	2008	135	86	65	32	16	35	51	5	0	0	0	0		31.76	20.24	15.29	7.53	3.76	8.24	12.00	1.18	0.00	0.00	0.00	0.00
	2014	137	86	61	24	23	47	39	6	1	1	0	0		32.24	20.24	14.35	5.65	5.41	11.06	9.18	1.41	0.24	0.24	0.00	0.00
Seaton	1998	90	67	39	66	9	26	81	47	0	0	0	0		21.18	15.76	9.18	15.53	2.12	6.12	19.06	11.06	0.00	0.00	0.00	0.00
	2008	99	68	39	52	16	50	55	43	1	2	0	0		23.29	16.00	9.18	12.24	3.76	11.76	12.94	10.12	0.24	0.47	0.00	0.00
	2014	103	70	39	52	14	52	49	43	1	2	0	0		24.24	16.47	9.18	12.24	3.29	12.24	11.53	10.12	0.24	0.47	0.00	0.00
Semaphore Park	1998	94	50	42	44	15	15	88	3	0	30	30	14		22.12	11.76	9.88	10.35	3.53	3.53	20.71	0.71	0.00	7.06	7.06	3.29
	2008	92	62	40	51	22	24	56	3	0	29	29	17		21.65	14.59	9.41	12.00	5.18	5.65	13.18	0.71	0.00	6.82	6.82	4.00
	2014	96	67	42	53	19	28	42	3	0	29	29	17		22.59	15.76	9.88	12.47	4.47	6.59	9.88	0.71	0.00	6.82	6.82	4.00
St Clair	1998	56	52	14	28	4	24	179	68	0	0	0	0		13.18	12.24	3.29	6.59	0.94	5.65	42.12	16.00	0.00	0.00	0.00	0.00
	2008	37	37	14	29	7	236	16	49	0	0	0	0		8.71	8.71	3.29	6.82	1.65	55.53	3.76	11.53	0.00	0.00	0.00	0.00
	2014	81	78	51	20	5	88	55	20	12	15	0	0		19.06	18.35	12.00	4.71	1.18	20.71	12.94	4.71	2.82	3.53	0.00	0.00

Suburb	Year	NUMBER OF POINTS PER SUBURB													PERCENT COVER PER SUBURB (%)										
		Impervious			Tree		Plantable Space		Other						Impervious			Tree		Plantable Space		Other				
		ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV		ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV
Tennyson	1998	57	35	29	23	6	10	67	0	0	2	122	74		13.41	8.24	6.82	5.41	1.41	2.35	15.76	0.00	0.00	0.47	28.71	17.41
	2008	65	44	30	17	8	10	56	0	0	1	119	75		15.29	10.35	7.06	4.00	1.88	2.35	13.18	0.00	0.00	0.24	28.00	17.65
	2014	67	42	30	19	12	14	42	0	0	1	124	74		15.76	9.88	7.06	4.47	2.82	3.29	9.88	0.00	0.00	0.24	29.18	17.41
Welland	1998	147	108	30	41	15	22	60	0	0	2	0	0		34.59	25.41	7.06	9.65	3.53	5.18	14.12	0.00	0.00	0.47	0.00	0.00
	2008	150	106	30	42	22	24	50	0	0	1	0	0		35.29	24.94	7.06	9.88	5.18	5.65	11.76	0.00	0.00	0.24	0.00	0.00
	2014	155	112	29	39	18	23	47	0	0	2	0	0		36.47	26.35	6.82	9.18	4.24	5.41	11.06	0.00	0.00	0.47	0.00	0.00
West Beach	1998	81	44	44	53	9	10	108	17	1	3	41	14		19.06	10.35	10.35	12.47	2.12	2.35	25.41	4.00	0.24	0.71	9.65	3.29
	2008	95	53	44	49	13	26	70	15	1	3	40	16		22.35	12.47	10.35	11.53	3.06	6.12	16.47	3.53	0.24	0.71	9.41	3.76
	2014	102	60	42	51	9	18	67	15	1	2	44	14		24.00	14.12	9.88	12.00	2.12	4.24	15.76	3.53	0.24	0.47	10.35	3.29
West Croydon	1998	117	97	50	48	19	14	72	8	0	0	0	0		27.53	22.82	11.76	11.29	4.47	3.29	16.94	1.88	0.00	0.00	0.00	0.00
	2008	124	101	52	38	21	22	59	8	0	0	0	0		29.18	23.76	12.24	8.94	4.94	5.18	13.88	1.88	0.00	0.00	0.00	0.00
	2014	131	99	50	47	20	18	52	8	0	0	0	0		30.82	23.29	11.76	11.06	4.71	4.24	12.24	1.88	0.00	0.00	0.00	0.00
West Hindmarsh	1998	123	79	51	62	22	15	70	0	2	1	0	0		28.94	18.59	12.00	14.59	5.18	3.53	16.47	0.00	0.47	0.24	0.00	0.00
	2008	129	83	50	55	25	35	45	0	3	0	0	0		30.35	19.53	11.76	12.94	5.88	8.24	10.59	0.00	0.71	0.00	0.00	0.00
	2014	130	88	52	46	27	26	54	0	2	0	0	0		30.59	20.71	12.24	10.82	6.35	6.12	12.71	0.00	0.47	0.00	0.00	0.00
West Lakes	1998	88	56	55	40	9	15	72	14	0	75	1	0		20.71	13.18	12.94	9.41	2.12	3.53	16.94	3.29	0.00	17.65	0.24	0.00
	2008	90	49	58	40	9	25	63	15	0	75	1	0		21.18	11.53	13.65	9.41	2.12	5.88	14.82	3.53	0.00	17.65	0.24	0.00
	2014	95	55	58	32	10	21	61	17	0	75	1	0		22.35	12.94	13.65	7.53	2.35	4.94	14.35	4.00	0.00	17.65	0.24	0.00
West Lakes Shore	1998	81	56	38	36	13	11	85	24	0	25	31	25		19.06	13.18	8.94	8.47	3.06	2.59	20.00	5.65	0.00	5.88	7.29	5.88
	2008	87	63	35	35	11	28	62	24	0	24	34	22		20.47	14.82	8.24	8.24	2.59	6.59	14.59	5.65	0.00	5.65	8.00	5.18
	2014	90	65	36	29	15	30	57	24	0	24	33	22		21.18	15.29	8.47	6.82	3.53	7.06	13.41	5.65	0.00	5.65	7.76	5.18

Suburb	Year	NUMBER OF POINTS PER SUBURB													PERCENT COVER PER SUBURB (%)										
		Impervious			Tree		Plantable Space		Other						Impervious			Tree		Plantable Space		Other				
		ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV		ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV
Woodville	1998	133	99	50	42	23	9	69	0	0	0	0	0		31.29	23.29	11.76	9.88	5.41	2.12	16.24	0.00	0.00	0.00	0.00	0.00
	2008	136	100	52	37	28	25	47	0	0	0	0	0		32.00	23.53	12.24	8.71	6.59	5.88	11.06	0.00	0.00	0.00	0.00	0.00
	2014	142	104	50	36	27	19	47	0	0	0	0	0		33.41	24.47	11.76	8.47	6.35	4.47	11.06	0.00	0.00	0.00	0.00	0.00
Woodville North	1998	142	82	31	44	15	18	87	6	0	0	0	0		33.41	19.29	7.29	10.35	3.53	4.24	20.47	1.41	0.00	0.00	0.00	0.00
	2008	149	104	31	30	18	24	63	6	0	0	0	0		35.06	24.47	7.29	7.06	4.24	5.65	14.82	1.41	0.00	0.00	0.00	0.00
	2014	164	106	35	26	10	21	57	6	0	0	0	0		38.59	24.94	8.24	6.12	2.35	4.94	13.41	1.41	0.00	0.00	0.00	0.00
Woodville Park	1998	119	93	31	57	21	12	92	0	0	0	0	0		28.00	21.88	7.29	13.41	4.94	2.82	21.65	0.00	0.00	0.00	0.00	0.00
	2008	122	98	30	56	27	18	74	0	0	0	0	0		28.71	23.06	7.06	13.18	6.35	4.24	17.41	0.00	0.00	0.00	0.00	0.00
	2014	124	102	30	49	27	16	77	0	0	0	0	0		29.18	24.00	7.06	11.53	6.35	3.76	18.12	0.00	0.00	0.00	0.00	0.00
Woodville South	1998	120	66	47	63	20	11	77	21	0	0	0	0		28.24	15.53	11.06	14.82	4.71	2.59	18.12	4.94	0.00	0.00	0.00	0.00
	2008	133	69	45	55	27	11	65	20	0	0	0	0		31.29	16.24	10.59	12.94	6.35	2.59	15.29	4.71	0.00	0.00	0.00	0.00
	2014	137	75	46	49	22	11	65	20	0	0	0	0		32.24	17.65	10.82	11.53	5.18	2.59	15.29	4.71	0.00	0.00	0.00	0.00
Woodville West	1998	102	77	45	49	19	15	117	1	0	0	0	0		24.00	18.12	10.59	11.53	4.47	3.53	27.53	0.24	0.00	0.00	0.00	0.00
	2008	111	85	46	54	20	54	54	1	0	0	0	0		26.12	20.00	10.82	12.71	4.71	12.71	12.71	0.24	0.00	0.00	0.00	0.00
	2014	110	83	44	38	19	70	57	4	0	0	0	0		25.88	19.53	10.35	8.94	4.47	16.47	13.41	0.94	0.00	0.00	0.00	0.00

Attachment C. Number of points and equivalent percent cover (%) for each land cover category in each tenure type in 2014 relative to the 425 points sampled in each suburb. Land cover categories are abbreviated as follows: ImpBld = impervious-building; ImpOth = impervious-other; ImpRd = impervious-road; TrPer = tree-pervious; TrImp = tree-impervious; BG = bare ground; GrOth = grass-other; GrSpt = grass sporting; WV = wetland vegetation; W = water; B = beach; DV = dune vegetation.

2014		NUMBER OF POINTS PER SUBURB												PERCENT COVER PER SUBURB (%)											
		Impervious			Tree		Plantable Space		Other					Impervious			Tree		Plantable Space		Other				
Suburb	Tenure	ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV	ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV
Albert Park	Private	142	71	1	26	8	26	37	0	0	0	0	0	33.41	16.71	0.24	6.12	1.88	6.12	8.71	0.00	0.00	0.00	0.00	0.00
	Public	1	22	39	9	15	15	13	0	0	0	0	0	0.24	5.18	9.18	2.12	3.53	3.53	3.06	0.00	0.00	0.00	0.00	0.00
Allenby Gardens	Private	130	37	0	30	5	28	49	1	0	0	0	0	30.59	8.71	0.00	7.06	1.18	6.59	11.53	0.24	0.00	0.00	0.00	0.00
	Public	0	20	51	23	17	8	20	5	1	0	0	0	0.00	4.71	12.00	5.41	4.00	1.88	4.71	1.18	0.24	0.00	0.00	0.00
Athol Park	Private	136	86	2	17	5	46	33	0	0	0	0	0	32.00	20.24	0.47	4.00	1.18	10.82	7.76	0.00	0.00	0.00	0.00	0.00
	Public	2	28	33	7	5	6	11	8	0	0	0	0	0.47	6.59	7.76	1.65	1.18	1.41	2.59	1.88	0.00	0.00	0.00	0.00
Beverley	Private	123	94	0	30	12	46	26	8	0	0	0	0	28.94	22.12	0.00	7.06	2.82	10.82	6.12	1.88	0.00	0.00	0.00	0.00
	Public	1	19	34	7	5	8	5	7	0	0	0	0	0.24	4.47	8.00	1.65	1.18	1.88	1.18	1.65	0.00	0.00	0.00	0.00
Bowden	Private	129	58	7	24	12	54	10	1	0	0	0	0	30.35	13.65	1.65	5.65	2.82	12.71	2.35	0.24	0.00	0.00	0.00	0.00
	Public	3	39	42	12	11	15	8	0	0	0	0	0	0.71	9.18	9.88	2.82	2.59	3.53	1.88	0.00	0.00	0.00	0.00	0.00
Brompton	Private	155	79	1	25	18	20	19	0	0	0	0	0	36.47	18.59	0.24	5.88	4.24	4.71	4.47	0.00	0.00	0.00	0.00	0.00
	Public	1	20	49	6	14	7	10	1	0	0	0	0	0.24	4.71	11.53	1.41	3.29	1.65	2.35	0.24	0.00	0.00	0.00	0.00
Cheltenham	Private	134	82	0	29	12	22	43	0	0	0	0	0	31.53	19.29	0.00	6.82	2.82	5.18	10.12	0.00	0.00	0.00	0.00	0.00
	Public	0	22	42	14	8	12	5	0	0	0	0	0	0.00	5.18	9.88	3.29	1.88	2.82	1.18	0.00	0.00	0.00	0.00	0.00
Croydon	Private	118	61	0	41	19	35	29	0	0	0	0	0	27.76	14.35	0.00	9.65	4.47	8.24	6.82	0.00	0.00	0.00	0.00	0.00
	Public	1	26	48	8	20	14	5	0	0	0	0	0	0.24	6.12	11.29	1.88	4.71	3.29	1.18	0.00	0.00	0.00	0.00	0.00
Devon Park	Private	131	53	0	35	20	24	28	0	0	0	0	0	30.82	12.47	0.00	8.24	4.71	5.65	6.59	0.00	0.00	0.00	0.00	0.00
	Public	0	25	72	8	15	10	4	0	0	0	0	0	0.00	5.88	16.94	1.88	3.53	2.35	0.94	0.00	0.00	0.00	0.00	0.00

2014		NUMBER OF POINTS PER SUBURB												PERCENT COVER PER SUBURB (%)											
		Impervious			Tree		Plantable Space		Other					Impervious			Tree		Plantable Space		Other				
Suburb	Tenure	ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV	ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV
Findon	Private	146	68	0	45	30	40	20	2	0	0	0	0	34.35	16.00	0.00	10.59	7.06	9.41	4.71	0.47	0.00	0.00	0.00	0.00
	Public	1	22	44	13	4	7	13	4	0	0	0	0	0.24	5.18	10.35	3.06	0.94	1.65	3.06	0.94	0.00	0.00	0.00	0.00
Flinders Park	Private	113	57	0	34	9	24	46	8	0	0	0	0	26.59	13.41	0.00	8.00	2.12	5.65	10.82	1.88	0.00	0.00	0.00	0.00
	Public	0	21	39	29	6	13	15	6	2	3	0	0	0.00	4.94	9.18	6.82	1.41	3.06	3.53	1.41	0.47	0.71	0.00	0.00
Fulham Gardens	Private	145	54	1	23	11	21	48	0	0	0	0	0	34.12	12.71	0.24	5.41	2.59	4.94	11.29	0.00	0.00	0.00	0.00	0.00
	Public	0	26	42	15	3	7	27	0	0	2	0	0	0.00	6.12	9.88	3.53	0.71	1.65	6.35	0.00	0.00	0.47	0.00	0.00
Grange	Private	83	32	2	49	10	31	30	78	0	0	0	0	19.53	7.53	0.47	11.53	2.35	7.29	7.06	18.35	0.00	0.00	0.00	0.00
	Public	1	11	28	16	6	7	11	4	1	2	17	6	0.24	2.59	6.59	3.76	1.41	1.65	2.59	0.94	0.24	0.47	4.00	1.41
Hendon	Private	146	81	10	16	7	35	26	0	0	0	0	0	34.35	19.06	2.35	3.76	1.65	8.24	6.12	0.00	0.00	0.00	0.00	0.00
	Public	3	11	56	9	4	14	7	0	0	0	0	0	0.71	2.59	13.18	2.12	0.94	3.29	1.65	0.00	0.00	0.00	0.00	0.00
Henley Beach	Private	119	37	1	26	11	20	35	7	0	0	0	0	28.00	8.71	0.24	6.12	2.59	4.71	8.24	1.65	0.00	0.00	0.00	0.00
	Public	2	28	42	14	6	17	18	8	0	0	30	4	0.47	6.59	9.88	3.29	1.41	4.00	4.24	1.88	0.00	0.00	7.06	0.94
Henley Beach South	Private	98	40	0	33	11	25	34	8	0	0	0	0	23.06	9.41	0.00	7.76	2.59	5.88	8.00	1.88	0.00	0.00	0.00	0.00
	Public	1	24	43	27	10	10	23	0	0	3	30	5	0.24	5.65	10.12	6.35	2.35	2.35	5.41	0.00	0.00	0.71	7.06	1.18
Hindmarsh	Private	155	96	3	9	7	9	3	5	0	0	0	0	36.47	22.59	0.71	2.12	1.65	2.12	0.71	1.18	0.00	0.00	0.00	0.00
	Public	6	25	55	16	18	11	4	0	1	2	0	0	1.41	5.88	12.94	3.76	4.24	2.59	0.94	0.00	0.24	0.47	0.00	0.00
Kidman Park	Private	133	64	3	34	4	20	39	9	0	0	0	0	31.29	15.06	0.71	8.00	0.94	4.71	9.18	2.12	0.00	0.00	0.00	0.00
	Public	2	19	29	16	11	12	20	8	0	2	0	0	0.47	4.47	6.82	3.76	2.59	2.82	4.71	1.88	0.00	0.47	0.00	0.00
Kilkenny	Private	159	107	7	19	11	20	16	4	0	0	0	0	37.41	25.18	1.65	4.47	2.59	4.71	3.76	0.94	0.00	0.00	0.00	0.00
	Public	0	13	53	2	5	4	5	0	0	0	0	0	0.00	3.06	12.47	0.47	1.18	0.94	1.18	0.00	0.00	0.00	0.00	0.00
Ovingham	Private	119	46	2	50	29	22	10	0	0	0	0	0	28.00	10.82	0.47	11.76	6.82	5.18	2.35	0.00	0.00	0.00	0.00	0.00
	Public	1	26	71	20	9	18	2	0	0	0	0	0	0.24	6.12	16.71	4.71	2.12	4.24	0.47	0.00	0.00	0.00	0.00	0.00

2014		NUMBER OF POINTS PER SUBURB												PERCENT COVER PER SUBURB (%)											
		Impervious			Tree		Plantable Space		Other					Impervious			Tree		Plantable Space		Other				
Suburb	Tenure	ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV	ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV
Pennington	Private	116	84	3	40	8	30	37	3	0	0	0	0	27.29	19.76	0.71	9.41	1.88	7.06	8.71	0.71	0.00	0.00	0.00	0.00
	Public	1	19	41	5	9	12	14	3	0	0	0	0	0.24	4.47	9.65	1.18	2.12	2.82	3.29	0.71	0.00	0.00	0.00	0.00
Renown Park	Private	108	54	0	37	12	21	29	7	0	0	0	0	25.41	12.71	0.00	8.71	2.82	4.94	6.82	1.65	0.00	0.00	0.00	0.00
	Public	1	23	51	30	9	17	5	21	0	0	0	0	0.24	5.41	12.00	7.06	2.12	4.00	1.18	4.94	0.00	0.00	0.00	0.00
Ridleyton	Private	127	87	0	25	19	26	21	0	0	0	0	0	29.88	20.47	0.00	5.88	4.47	6.12	4.94	0.00	0.00	0.00	0.00	0.00
	Public	2	23	38	11	11	17	13	5	0	0	0	0	0.47	5.41	8.94	2.59	2.59	4.00	3.06	1.18	0.00	0.00	0.00	0.00
Royal Park	Private	136	64	1	16	15	32	29	2	0	0	0	0	32.00	15.06	0.24	3.76	3.53	7.53	6.82	0.47	0.00	0.00	0.00	0.00
	Public	1	22	60	8	8	15	10	4	1	1	0	0	0.24	5.18	14.12	1.88	1.88	3.53	2.35	0.94	0.24	0.24	0.00	0.00
Seaton	Private	103	52	0	40	10	49	35	40	1	2	0	0	24.24	12.24	0.00	9.41	2.35	11.53	8.24	9.41	0.24	0.47	0.00	0.00
	Public	0	18	39	12	4	3	14	3	0	0	0	0	0.00	4.24	9.18	2.82	0.94	0.71	3.29	0.71	0.00	0.00	0.00	0.00
Semaphore Park	Private	95	48	0	33	14	15	31	0	0	0	0	1	22.35	11.29	0.00	7.76	3.29	3.53	7.29	0.00	0.00	0.00	0.00	0.24
	Public	1	19	42	20	5	13	11	3	0	29	29	16	0.24	4.47	9.88	4.71	1.18	3.06	2.59	0.71	0.00	6.82	6.82	3.76
St Clair	Private	74	32	2	53	6	8	13	3	0	0	0	0	17.41	7.53	0.47	12.47	1.41	1.88	3.06	0.71	0.00	0.00	0.00	0.00
	Public	7	46	49	35	14	17	42	17	12	15	0	0	1.65	10.82	11.53	8.24	3.29	4.00	9.88	4.00	2.82	3.53	0.00	0.00
Tennyson	Private	67	24	1	12	10	4	24	0	0	0	1	0	15.76	5.65	0.24	2.82	2.35	0.94	5.65	0.00	0.00	0.00	0.24	0.00
	Public	0	18	29	7	2	10	18	0	0	1	123	74	0.00	4.24	6.82	1.65	0.47	2.35	4.24	0.00	0.00	0.24	28.94	17.41
Welland	Private	155	100	0	27	13	21	40	0	0	0	0	0	36.47	23.53	0.00	6.35	3.06	4.94	9.41	0.00	0.00	0.00	0.00	0.00
	Public	0	12	29	12	5	2	7	0	0	2	0	0	0.00	2.82	6.82	2.82	1.18	0.47	1.65	0.00	0.00	0.47	0.00	0.00
West Beach	Private	102	36	6	30	6	11	46	15	0	0	10	4	24.00	8.47	1.41	7.06	1.41	2.59	10.82	3.53	0.00	0.00	2.35	0.94
	Public	0	24	36	21	3	7	21	0	1	2	34	10	0.00	5.65	8.47	4.94	0.71	1.65	4.94	0.00	0.24	0.47	8.00	2.35
West Croydon	Private	131	70	0	36	6	13	46	8	0	0	0	0	30.82	16.47	0.00	8.47	1.41	3.06	10.82	1.88	0.00	0.00	0.00	0.00
	Public	0	29	50	11	14	5	6	0	0	0	0	0	0.00	6.82	11.76	2.59	3.29	1.18	1.41	0.00	0.00	0.00	0.00	0.00

2014		NUMBER OF POINTS PER SUBURB												PERCENT COVER PER SUBURB (%)											
		Impervious			Tree		Plantable Space		Other					Impervious			Tree		Plantable Space		Other				
Suburb	Tenure	ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV	ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV
West Hindmarsh	Private	130	62	0	32	14	14	47	0	0	0	0	0	30.59	14.59	0.00	7.53	3.29	3.29	11.06	0.00	0.00	0.00	0.00	0.00
	Public	0	26	52	14	13	12	7	0	2	0	0	0	0.00	6.12	12.24	3.29	3.06	2.82	1.65	0.00	0.47	0.00	0.00	0.00
West Lakes	Private	94	34	4	23	8	10	29	17	0	0	0	0	22.12	8.00	0.94	5.41	1.88	2.35	6.82	4.00	0.00	0.00	0.00	0.00
	Public	1	21	54	9	2	11	32	0	0	75	1	0	0.24	4.94	12.71	2.12	0.47	2.59	7.53	0.00	0.00	17.65	0.24	0.00
West Lakes Shore	Private	88	45	0	20	5	13	35	2	0	0	0	0	20.71	10.59	0.00	4.71	1.18	3.06	8.24	0.47	0.00	0.00	0.00	0.00
	Public	2	20	36	9	10	17	22	22	0	24	33	22	0.47	4.71	8.47	2.12	2.35	4.00	5.18	5.18	0.00	5.65	7.76	5.18
Woodville	Private	135	74	4	30	13	11	42	0	0	0	0	0	31.76	17.41	0.94	7.06	3.06	2.59	9.88	0.00	0.00	0.00	0.00	0.00
	Public	7	30	46	6	14	8	5	0	0	0	0	0	1.65	7.06	10.82	1.41	3.29	1.88	1.18	0.00	0.00	0.00	0.00	0.00
Woodville North	Private	162	84	5	20	6	17	48	0	0	0	0	0	38.12	19.76	1.18	4.71	1.41	4.00	11.29	0.00	0.00	0.00	0.00	0.00
	Public	2	22	30	6	4	4	9	6	0	0	0	0	0.47	5.18	7.06	1.41	0.94	0.94	2.12	1.41	0.00	0.00	0.00	0.00
Woodville Park	Private	123	74	0	34	18	14	63	0	0	0	0	0	28.94	17.41	0.00	8.00	4.24	3.29	14.82	0.00	0.00	0.00	0.00	0.00
	Public	1	28	30	15	9	2	14	0	0	0	0	0	0.24	6.59	7.06	3.53	2.12	0.47	3.29	0.00	0.00	0.00	0.00	0.00
Woodville South	Private	137	53	3	41	16	7	50	3	0	0	0	0	32.24	12.47	0.71	9.65	3.76	1.65	11.76	0.71	0.00	0.00	0.00	0.00
	Public	0	22	43	8	6	4	15	17	0	0	0	0	0.00	5.18	10.12	1.88	1.41	0.94	3.53	4.00	0.00	0.00	0.00	0.00
Woodville West	Private	110	59	0	58	30	34	46	0	0	0	0	0	25.88	13.88	0.00	13.65	7.06	8.00	10.82	0.00	0.00	0.00	0.00	0.00
	Public	0	24	44	12	8	23	11	4	0	0	0	0	0.00	5.65	10.35	2.82	1.88	5.41	2.59	0.94	0.00	0.00	0.00	0.00

Attachment D. Number of points and equivalent percent cover (%) for each land cover category in each tenure type in 2008 relative to the 425 points sampled in each suburb. Land cover categories are abbreviated as follows: ImpBld = impervious-building; ImpOth = impervious-other; ImpRd = impervious-road; TrPer = tree-pervious; TrImp = tree-impervious; BG = bare ground; GrOth = grass-other; GrSpt = grass sporting; WV = wetland vegetation; W = water; B = beach; DV = dune vegetation.

2008		NUMBER OF POINTS PER SUBURB												PERCENT COVER PER SUBURB (%)											
		Impervious			Tree		Plantable Space		Other					Impervious			Tree		Plantable Space		Other				
Suburb	Tenure	ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV	ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV
Albert Park	Private	138	66	1	31	8	27	40	0	0	0	0	0	32.47	15.53	0.24	7.29	1.88	6.35	9.41	0.00	0.00	0.00	0.00	0.00
	Public	1	25	39	11	11	17	10	0	0	0	0	0	0.24	5.88	9.18	2.59	2.59	4.00	2.35	0.00	0.00	0.00	0.00	0.00
Allenby Gardens	Private	142	77	10	19	7	31	35	0	0	0	0	0	33.41	18.12	2.35	4.47	1.65	7.29	8.24	0.00	0.00	0.00	0.00	0.00
	Public	0	19	51	26	17	7	19	5	1	0	0	0	0.00	4.47	12.00	6.12	4.00	1.65	4.47	1.18	0.24	0.00	0.00	0.00
Athol Park	Private	125	38	0	40	7	37	32	1	0	0	0	0	29.41	8.94	0.00	9.41	1.65	8.71	7.53	0.24	0.00	0.00	0.00	0.00
	Public	2	16	31	9	7	16	11	8	0	0	0	0	0.47	3.76	7.29	2.12	1.65	3.76	2.59	1.88	0.00	0.00	0.00	0.00
Beverley	Private	114	36	1	36	11	11	40	7	0	0	0	0	26.82	8.47	0.24	8.47	2.59	2.59	9.41	1.65	0.00	0.00	0.00	0.00
	Public	2	15	34	8	6	9	5	7	0	0	0	0	0.47	3.53	8.00	1.88	1.41	2.12	1.18	1.65	0.00	0.00	0.00	0.00
Bowden	Private	99	78	2	23	10	85	28	0	0	0	0	0	23.29	18.35	0.47	5.41	2.35	20.00	6.59	0.00	0.00	0.00	0.00	0.00
	Public	6	43	40	17	10	7	6	1	0	0	0	0	1.41	10.12	9.41	4.00	2.35	1.65	1.41	0.24	0.00	0.00	0.00	0.00
Brompton	Private	95	37	0	37	8	21	43	8	0	0	0	0	22.35	8.71	0.00	8.71	1.88	4.94	10.12	1.88	0.00	0.00	0.00	0.00
	Public	1	16	43	6	16	16	9	1	0	0	0	0	0.24	3.76	10.12	1.41	3.76	3.76	2.12	0.24	0.00	0.00	0.00	0.00
Cheltenham	Private	129	88	0	32	13	37	32	8	0	0	0	0	30.35	20.71	0.00	7.53	3.06	8.71	7.53	1.88	0.00	0.00	0.00	0.00
	Public	0	23	43	15	6	12	4	0	0	0	0	0	0.00	5.41	10.12	3.53	1.41	2.82	0.94	0.00	0.00	0.00	0.00	0.00
Croydon	Private	141	96	1	12	8	17	7	5	0	0	0	0	33.18	22.59	0.24	2.82	1.88	4.00	1.65	1.18	0.00	0.00	0.00	0.00
	Public	1	22	49	11	22	12	5	0	0	0	0	0	0.24	5.18	11.53	2.59	5.18	2.82	1.18	0.00	0.00	0.00	0.00	0.00
Devon Park	Private	149	60	7	27	12	30	9	1	0	0	0	0	35.06	14.12	1.65	6.35	2.82	7.06	2.12	0.24	0.00	0.00	0.00	0.00
	Public	0	24	72	7	15	13	3	0	0	0	0	0	0.00	5.65	16.94	1.65	3.53	3.06	0.71	0.00	0.00	0.00	0.00	0.00

2008		NUMBER OF POINTS PER SUBURB												PERCENT COVER PER SUBURB (%)											
		Impervious			Tree		Plantable Space		Other					Impervious			Tree		Plantable Space		Other				
Suburb	Tenure	ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV	ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV
Findon	Private	134	60	0	45	39	50	31	1	0	0	0	0	31.53	14.12	0.00	10.59	9.18	11.76	7.29	0.24	0.00	0.00	0.00	0.00
	Public	2	21	44	13	4	6	13	5	0	0	0	0	0.47	4.94	10.35	3.06	0.94	1.41	3.06	1.18	0.00	0.00	0.00	0.00
Flinders Park	Private	125	61	2	30	10	20	49	9	0	0	0	0	29.41	14.35	0.47	7.06	2.35	4.71	11.53	2.12	0.00	0.00	0.00	0.00
	Public	0	21	38	30	7	12	15	6	2	3	0	0	0.00	4.94	8.94	7.06	1.65	2.82	3.53	1.41	0.47	0.71	0.00	0.00
Fulham Gardens	Private	132	76	1	29	17	39	23	0	0	0	0	0	31.06	17.88	0.24	6.82	4.00	9.18	5.41	0.00	0.00	0.00	0.00	0.00
	Public	0	26	42	18	3	5	26	0	0	2	0	0	0.00	6.12	9.88	4.24	0.71	1.18	6.12	0.00	0.00	0.47	0.00	0.00
Grange	Private	149	93	5	20	12	32	28	4	0	0	0	0	35.06	21.88	1.18	4.71	2.82	7.53	6.59	0.94	0.00	0.00	0.00	0.00
	Public	1	11	28	14	7	6	13	4	1	2	17	6	0.24	2.59	6.59	3.29	1.65	1.41	3.06	0.94	0.24	0.47	4.00	1.41
Hendon	Private	132	83	0	30	11	22	44	0	0	0	0	0	31.06	19.53	0.00	7.06	2.59	5.18	10.35	0.00	0.00	0.00	0.00	0.00
	Public	3	12	56	10	2	7	14	0	0	0	0	0	0.71	2.82	13.18	2.35	0.47	1.65	3.29	0.00	0.00	0.00	0.00	0.00
Henley Beach	Private	111	45	2	51	30	20	19	0	0	0	0	0	26.12	10.59	0.47	12.00	7.06	4.71	4.47	0.00	0.00	0.00	0.00	0.00
	Public	2	25	42	18	7	11	22	8	0	0	30	4	0.47	5.88	9.88	4.24	1.65	2.59	5.18	1.88	0.00	0.00	7.06	0.94
Henley Beach South	Private	113	60	0	38	19	32	41	0	0	0	0	0	26.59	14.12	0.00	8.94	4.47	7.53	9.65	0.00	0.00	0.00	0.00	0.00
	Public	1	18	46	27	10	12	24	0	0	3	25	10	0.24	4.24	10.82	6.35	2.35	2.82	5.65	0.00	0.00	0.71	5.88	2.35
Hindmarsh	Private	108	84	3	42	7	25	49	3	0	0	0	0	25.41	19.76	0.71	9.88	1.65	5.88	11.53	0.71	0.00	0.00	0.00	0.00
	Public	6	24	57	16	14	10	8	0	1	2	0	0	1.41	5.65	13.41	3.76	3.29	2.35	1.88	0.00	0.24	0.47	0.00	0.00
Kidman Park	Private	128	45	0	48	23	22	25	0	0	0	0	0	30.12	10.59	0.00	11.29	5.41	5.18	5.88	0.00	0.00	0.00	0.00	0.00
	Public	2	18	28	15	13	10	23	8	0	2	0	0	0.47	4.24	6.59	3.53	3.06	2.35	5.41	1.88	0.00	0.47	0.00	0.00
Kilkenny	Private	102	50	0	40	16	19	34	7	0	0	0	0	24.00	11.76	0.00	9.41	3.76	4.47	8.00	1.65	0.00	0.00	0.00	0.00
	Public	0	12	53	3	6	4	4	0	0	0	0	0	0.00	2.82	12.47	0.71	1.41	0.94	0.94	0.00	0.00	0.00	0.00	0.00
Ovingham	Private	105	57	0	42	9	22	48	8	0	0	0	0	24.71	13.41	0.00	9.88	2.12	5.18	11.29	1.88	0.00	0.00	0.00	0.00
	Public	1	26	68	20	12	19	1	0	0	0	0	0	0.24	6.12	16.00	4.71	2.82	4.47	0.24	0.00	0.00	0.00	0.00	0.00

2008		NUMBER OF POINTS PER SUBURB												PERCENT COVER PER SUBURB (%)											
		Impervious			Tree		Plantable Space		Other					Impervious			Tree		Plantable Space		Other				
Suburb	Tenure	ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV	ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV
Pennington	Private	119	77	1	24	21	28	35	0	0	0	0	0	28.00	18.12	0.24	5.65	4.94	6.59	8.24	0.00	0.00	0.00	0.00	0.00
	Public	0	17	43	6	9	9	17	3	0	0	0	0	0.00	4.00	10.12	1.41	2.12	2.12	4.00	0.71	0.00	0.00	0.00	0.00
Renown Park	Private	146	51	1	27	9	15	54	0	0	0	0	0	34.35	12.00	0.24	6.35	2.12	3.53	12.71	0.00	0.00	0.00	0.00	0.00
	Public	1	23	53	32	6	15	6	21	0	0	0	0	0.24	5.41	12.47	7.53	1.41	3.53	1.41	4.94	0.00	0.00	0.00	0.00
Ridleyton	Private	134	63	2	23	12	22	38	1	0	0	0	0	31.53	14.82	0.47	5.41	2.82	5.18	8.94	0.24	0.00	0.00	0.00	0.00
	Public	2	24	42	9	6	16	16	5	0	0	0	0	0.47	5.65	9.88	2.12	1.41	3.76	3.76	1.18	0.00	0.00	0.00	0.00
Royal Park	Private	78	36	1	57	9	24	32	78	0	0	0	0	18.35	8.47	0.24	13.41	2.12	5.65	7.53	18.35	0.00	0.00	0.00	0.00
	Public	1	23	63	9	4	13	13	4	0	0	0	0	0.24	5.41	14.82	2.12	0.94	3.06	3.06	0.94	0.00	0.00	0.00	0.00
Seaton	Private	99	49	0	42	13	47	39	40	1	2	0	0	23.29	11.53	0.00	9.88	3.06	11.06	9.18	9.41	0.24	0.47	0.00	0.00
	Public	0	19	39	10	3	3	16	3	0	0	0	0	0.00	4.47	9.18	2.35	0.71	0.71	3.76	0.71	0.00	0.00	0.00	0.00
Semaphore Park	Private	91	41	0	31	17	15	41	0	0	0	0	1	21.41	9.65	0.00	7.29	4.00	3.53	9.65	0.00	0.00	0.00	0.00	0.24
	Public	1	21	40	20	5	9	15	3	0	29	29	16	0.24	4.94	9.41	4.71	1.18	2.12	3.53	0.71	0.00	6.82	6.82	3.76
St Clair	Private	28	20	0	100	8	12	5	20	0	0	0	0	6.59	4.71	0.00	23.53	1.88	2.82	1.18	4.71	0.00	0.00	0.00	0.00
	Public	9	17	14	136	21	24	11	29	0	0	0	0	2.12	4.00	3.29	32.00	4.94	5.65	2.59	6.82	0.00	0.00	0.00	0.00
Tennyson	Private	65	25	1	12	8	1	31	0	0	0	0	0	15.29	5.88	0.24	2.82	1.88	0.24	7.29	0.00	0.00	0.00	0.00	0.00
	Public	0	19	29	5	0	9	25	0	0	1	119	75	0.00	4.47	6.82	1.18	0.00	2.12	5.88	0.00	0.00	0.24	28.00	17.65
Welland	Private	150	96	0	33	16	22	39	0	0	0	0	0	35.29	22.59	0.00	7.76	3.76	5.18	9.18	0.00	0.00	0.00	0.00	0.00
	Public	0	10	30	9	6	2	11	0	0	1	0	0	0.00	2.35	7.06	2.12	1.41	0.47	2.59	0.00	0.00	0.24	0.00	0.00
West Beach	Private	95	31	7	29	10	17	48	15	0	0	10	4	22.35	7.29	1.65	6.82	2.35	4.00	11.29	3.53	0.00	0.00	2.35	0.94
	Public	0	22	37	20	3	9	22	0	1	3	30	12	0.00	5.18	8.71	4.71	0.71	2.12	5.18	0.00	0.24	0.71	7.06	2.82
West Croydon	Private	124	70	0	27	11	17	53	8	0	0	0	0	29.18	16.47	0.00	6.35	2.59	4.00	12.47	1.88	0.00	0.00	0.00	0.00
	Public	0	31	52	11	10	5	6	0	0	0	0	0	0.00	7.29	12.24	2.59	2.35	1.18	1.41	0.00	0.00	0.00	0.00	0.00

2008		NUMBER OF POINTS PER SUBURB												PERCENT COVER PER SUBURB (%)											
		Impervious			Tree		Plantable Space		Other					Impervious			Tree		Plantable Space		Other				
Suburb	Tenure	ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV	ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV
West Hindmarsh	Private	129	54	0	41	13	22	40	0	0	0	0	0	30.35	12.71	0.00	9.65	3.06	5.18	9.41	0.00	0.00	0.00	0.00	0.00
	Public	0	29	50	14	12	13	5	0	3	0	0	0	0.00	6.82	11.76	3.29	2.82	3.06	1.18	0.00	0.71	0.00	0.00	0.00
West Lakes	Private	89	34	4	28	5	10	34	15	0	0	0	0	20.94	8.00	0.94	6.59	1.18	2.35	8.00	3.53	0.00	0.00	0.00	0.00
	Public	1	15	54	12	4	15	29	0	0	75	1	0	0.24	3.53	12.71	2.82	0.94	3.53	6.82	0.00	0.00	17.65	0.24	0.00
West Lakes Shore	Private	84	44	0	25	5	14	34	2	0	0	0	0	19.76	10.35	0.00	5.88	1.18	3.29	8.00	0.47	0.00	0.00	0.00	0.00
	Public	3	19	35	10	6	14	28	22	0	24	34	22	0.71	4.47	8.24	2.35	1.41	3.29	6.59	5.18	0.00	5.65	8.00	5.18
Woodville	Private	129	71	4	31	15	18	41	0	0	0	0	0	30.35	16.71	0.94	7.29	3.53	4.24	9.65	0.00	0.00	0.00	0.00	0.00
	Public	7	29	48	6	13	7	6	0	0	0	0	0	1.65	6.82	11.29	1.41	3.06	1.65	1.41	0.00	0.00	0.00	0.00	0.00
Woodville North	Private	147	83	3	24	9	23	53	0	0	0	0	0	34.59	19.53	0.71	5.65	2.12	5.41	12.47	0.00	0.00	0.00	0.00	0.00
	Public	2	21	28	6	9	1	10	6	0	0	0	0	0.47	4.94	6.59	1.41	2.12	0.24	2.35	1.41	0.00	0.00	0.00	0.00
Woodville Park	Private	121	69	0	44	18	15	59	0	0	0	0	0	28.47	16.24	0.00	10.35	4.24	3.53	13.88	0.00	0.00	0.00	0.00	0.00
	Public	1	29	30	12	9	3	15	0	0	0	0	0	0.24	6.82	7.06	2.82	2.12	0.71	3.53	0.00	0.00	0.00	0.00	0.00
Woodville South	Private	133	49	3	43	18	9	52	3	0	0	0	0	31.29	11.53	0.71	10.12	4.24	2.12	12.24	0.71	0.00	0.00	0.00	0.00
	Public	0	20	42	12	9	2	13	17	0	0	0	0	0.00	4.71	9.88	2.82	2.12	0.47	3.06	4.00	0.00	0.00	0.00	0.00
Woodville West	Private	109	60	0	42	44	51	45	0	0	0	0	0	25.65	14.12	0.00	9.88	10.35	12.00	10.59	0.00	0.00	0.00	0.00	0.00
	Public	2	25	46	12	10	23	9	1	0	0	0	0	0.47	5.88	10.82	2.82	2.35	5.41	2.12	0.24	0.00	0.00	0.00	0.00

Attachment E. Number of points and equivalent percent cover (%) for each land cover category in each tenure type in 1998 relative to the 425 points sampled in each suburb. Land cover categories are abbreviated as follows: ImpBld = impervious-building; ImpOth = impervious-other; ImpRd = impervious-road; TrPer = tree-pervious; TrImp = tree-impervious; BG = bare ground; GrOth = grass-other; GrSpt = grass sporting; WV = wetland vegetation; W = water; B = beach; DV = dune vegetation.

1998		NUMBER OF POINTS PER SUBURB												PERCENT COVER PER SUBURB (%)											
		Impervious			Tree		Plantable Space		Other					Impervious			Tree		Plantable Space		Other				
Suburb	Tenure	ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV	ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV
Albert Park	Private	137	70	1	24	6	14	59	0	0	0	0	0	32.24	16.47	0.24	5.65	1.41	3.29	13.88	0.00	0.00	0.00	0.00	0.00
	Public	1	22	40	9	13	8	21	0	0	0	0	0	0.24	5.18	9.41	2.12	3.06	1.88	4.94	0.00	0.00	0.00	0.00	0.00
Allenby Gardens	Private	109	38	0	29	7	52	44	1	0	0	0	0	25.65	8.94	0.00	6.82	1.65	12.24	10.35	0.24	0.00	0.00	0.00	0.00
	Public	0	18	52	19	14	13	23	5	1	0	0	0	0.00	4.24	12.24	4.47	3.29	3.06	5.41	1.18	0.24	0.00	0.00	0.00
Athol Park	Private	112	82	3	20	2	19	87	0	0	0	0	0	26.35	19.29	0.71	4.71	0.47	4.47	20.47	0.00	0.00	0.00	0.00	0.00
	Public	2	22	32	7	4	3	22	8	0	0	0	0	0.47	5.18	7.53	1.65	0.94	0.71	5.18	1.88	0.00	0.00	0.00	0.00
Beverley	Private	125	95	2	28	15	24	43	7	0	0	0	0	29.41	22.35	0.47	6.59	3.53	5.65	10.12	1.65	0.00	0.00	0.00	0.00
	Public	4	15	34	9	6	2	9	7	0	0	0	0	0.94	3.53	8.00	2.12	1.41	0.47	2.12	1.65	0.00	0.00	0.00	0.00
Bowden	Private	144	59	7	26	7	20	31	1	0	0	0	0	33.88	13.88	1.65	6.12	1.65	4.71	7.29	0.24	0.00	0.00	0.00	0.00
	Public	5	39	41	11	11	10	13	0	0	0	0	0	1.18	9.18	9.65	2.59	2.59	2.35	3.06	0.00	0.00	0.00	0.00	0.00
Brompton	Private	125	79	1	28	10	22	52	0	0	0	0	0	29.41	18.59	0.24	6.59	2.35	5.18	12.24	0.00	0.00	0.00	0.00	0.00
	Public	3	24	42	2	4	17	15	1	0	0	0	0	0.71	5.65	9.88	0.47	0.94	4.00	3.53	0.24	0.00	0.00	0.00	0.00
Cheltenham	Private	124	76	0	48	6	13	55	0	0	0	0	0	29.18	17.88	0.00	11.29	1.41	3.06	12.94	0.00	0.00	0.00	0.00	0.00
	Public	0	22	43	14	7	5	12	0	0	0	0	0	0.00	5.18	10.12	3.29	1.65	1.18	2.82	0.00	0.00	0.00	0.00	0.00
Croydon	Private	113	61	0	39	15	14	61	0	0	0	0	0	26.59	14.35	0.00	9.18	3.53	3.29	14.35	0.00	0.00	0.00	0.00	0.00
	Public	3	25	50	9	19	10	6	0	0	0	0	0	0.71	5.88	11.76	2.12	4.47	2.35	1.41	0.00	0.00	0.00	0.00	0.00
Devon Park	Private	126	57	0	42	11	10	45	0	0	0	0	0	29.65	13.41	0.00	9.88	2.59	2.35	10.59	0.00	0.00	0.00	0.00	0.00
	Public	0	29	80	6	5	4	10	0	0	0	0	0	0.00	6.82	18.82	1.41	1.18	0.94	2.35	0.00	0.00	0.00	0.00	0.00

1998		NUMBER OF POINTS PER SUBURB												PERCENT COVER PER SUBURB (%)											
		Impervious			Tree		Plantable Space		Other					Impervious			Tree		Plantable Space		Other				
Suburb	Tenure	ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV	ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV
Findon	Private	121	67	0	38	5	25	62	3	0	0	0	0	28.47	15.76	0.00	8.94	1.18	5.88	14.59	0.71	0.00	0.00	0.00	0.00
	Public	2	20	42	3	4	5	23	5	0	0	0	0	0.47	4.71	9.88	0.71	0.94	1.18	5.41	1.18	0.00	0.00	0.00	0.00
Flinders Park	Private	95	43	0	36	16	26	67	8	0	0	0	0	22.35	10.12	0.00	8.47	3.76	6.12	15.76	1.88	0.00	0.00	0.00	0.00
	Public	1	18	34	28	8	8	28	6	1	2	0	0	0.24	4.24	8.00	6.59	1.88	1.88	6.59	1.41	0.24	0.47	0.00	0.00
Fulham Gardens	Private	127	58	1	25	6	11	75	0	0	0	0	0	29.88	13.65	0.24	5.88	1.41	2.59	17.65	0.00	0.00	0.00	0.00	0.00
	Public	0	25	41	12	3	4	35	0	0	2	0	0	0.00	5.88	9.65	2.82	0.71	0.94	8.24	0.00	0.00	0.47	0.00	0.00
Grange	Private	63	31	1	56	9	10	74	70	0	1	0	0	14.82	7.29	0.24	13.18	2.12	2.35	17.41	16.47	0.00	0.24	0.00	0.00
	Public	2	9	29	13	4	0	23	4	1	2	17	6	0.47	2.12	6.82	3.06	0.94	0.00	5.41	0.94	0.24	0.47	4.00	1.41
Hendon	Private	121	76	10	22	8	13	71	0	0	0	0	0	28.47	17.88	2.35	5.18	1.88	3.06	16.71	0.00	0.00	0.00	0.00	0.00
	Public	2	13	56	14	3	2	13	0	0	1	0	0	0.47	3.06	13.18	3.29	0.71	0.47	3.06	0.00	0.00	0.24	0.00	0.00
Henley Beach	Private	104	35	1	37	13	2	57	7	0	0	0	0	24.47	8.24	0.24	8.71	3.06	0.47	13.41	1.65	0.00	0.00	0.00	0.00
	Public	2	17	40	16	9	3	39	8	0	0	34	1	0.47	4.00	9.41	3.76	2.12	0.71	9.18	1.88	0.00	0.00	8.00	0.24
Henley Beach South	Private	82	31	0	43	13	6	66	8	0	0	0	0	19.29	7.29	0.00	10.12	3.06	1.41	15.53	1.88	0.00	0.00	0.00	0.00
	Public	1	20	45	23	8	1	38	0	0	3	30	7	0.24	4.71	10.59	5.41	1.88	0.24	8.94	0.00	0.00	0.71	7.06	1.65
Hindmarsh	Private	135	91	3	13	15	11	14	5	0	0	0	0	31.76	21.41	0.71	3.06	3.53	2.59	3.29	1.18	0.00	0.00	0.00	0.00
	Public	6	26	58	12	9	9	14	0	3	1	0	0	1.41	6.12	13.65	2.82	2.12	2.12	3.29	0.00	0.71	0.24	0.00	0.00
Kidman Park	Private	108	59	2	38	6	15	66	12	0	0	0	0	25.41	13.88	0.47	8.94	1.41	3.53	15.53	2.82	0.00	0.00	0.00	0.00
	Public	2	19	30	13	10	6	29	8	0	2	0	0	0.47	4.47	7.06	3.06	2.35	1.41	6.82	1.88	0.00	0.47	0.00	0.00
Kilkenny	Private	146	99	4	24	9	14	43	4	0	0	0	0	34.35	23.29	0.94	5.65	2.12	3.29	10.12	0.94	0.00	0.00	0.00	0.00
	Public	1	12	55	4	3	3	4	0	0	0	0	0	0.24	2.82	12.94	0.94	0.71	0.71	0.94	0.00	0.00	0.00	0.00	0.00
Ovingham	Private	108	39	1	77	19	6	28	0	0	0	0	0	25.41	9.18	0.24	18.12	4.47	1.41	6.59	0.00	0.00	0.00	0.00	0.00
	Public	1	30	73	14	6	9	14	0	0	0	0	0	0.24	7.06	17.18	3.29	1.41	2.12	3.29	0.00	0.00	0.00	0.00	0.00

1998		NUMBER OF POINTS PER SUBURB												PERCENT COVER PER SUBURB (%)											
		Impervious			Tree		Plantable Space		Other					Impervious			Tree		Plantable Space		Other				
Suburb	Tenure	ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV	ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV
Pennington	Private	98	76	2	45	8	15	74	3	0	0	0	0	23.06	17.88	0.47	10.59	1.88	3.53	17.41	0.71	0.00	0.00	0.00	0.00
	Public	1	16	43	5	7	3	26	3	0	0	0	0	0.24	3.76	10.12	1.18	1.65	0.71	6.12	0.71	0.00	0.00	0.00	0.00
Renown Park	Private	105	49	0	32	10	11	54	7	0	0	0	0	24.71	11.53	0.00	7.53	2.35	2.59	12.71	1.65	0.00	0.00	0.00	0.00
	Public	1	25	52	24	7	9	17	22	0	0	0	0	0.24	5.88	12.24	5.65	1.65	2.12	4.00	5.18	0.00	0.00	0.00	0.00
Ridleyton	Private	112	70	0	30	19	17	57	0	0	0	0	0	26.35	16.47	0.00	7.06	4.47	4.00	13.41	0.00	0.00	0.00	0.00	0.00
	Public	2	25	37	8	5	7	27	9	0	0	0	0	0.47	5.88	8.71	1.88	1.18	1.65	6.35	2.12	0.00	0.00	0.00	0.00
Royal Park	Private	118	53	1	28	12	13	68	2	0	0	0	0	27.76	12.47	0.24	6.59	2.82	3.06	16.00	0.47	0.00	0.00	0.00	0.00
	Public	0	17	59	16	5	4	23	6	0	0	0	0	0.00	4.00	13.88	3.76	1.18	0.94	5.41	1.41	0.00	0.00	0.00	0.00
Seaton	Private	90	48	0	57	7	23	62	45	0	0	0	0	21.18	11.29	0.00	13.41	1.65	5.41	14.59	10.59	0.00	0.00	0.00	0.00
	Public	0	19	39	9	2	3	19	2	0	0	0	0	0.00	4.47	9.18	2.12	0.47	0.71	4.47	0.47	0.00	0.00	0.00	0.00
Semaphore Park	Private	93	32	0	27	10	8	66	0	0	0	0	1	21.88	7.53	0.00	6.35	2.35	1.88	15.53	0.00	0.00	0.00	0.00	0.24
	Public	1	18	42	17	5	7	22	3	0	30	30	13	0.24	4.24	9.88	4.00	1.18	1.65	5.18	0.71	0.00	7.06	7.06	3.06
St Clair	Private	35	28	0	7	2	10	67	36	0	0	0	0	8.24	6.59	0.00	1.65	0.47	2.35	15.76	8.47	0.00	0.00	0.00	0.00
	Public	21	24	14	21	2	14	112	32	0	0	0	0	4.94	5.65	3.29	4.94	0.47	3.29	26.35	7.53	0.00	0.00	0.00	0.00
Tennyson	Private	57	18	1	16	6	9	36	0	0	0	0	0	13.41	4.24	0.24	3.76	1.41	2.12	8.47	0.00	0.00	0.00	0.00	0.00
	Public	0	17	28	7	0	1	31	0	0	2	122	74	0.00	4.00	6.59	1.65	0.00	0.24	7.29	0.00	0.00	0.47	28.71	17.41
Welland	Private	147	98	1	34	9	20	47	0	0	0	0	0	34.59	23.06	0.24	8.00	2.12	4.71	11.06	0.00	0.00	0.00	0.00	0.00
	Public	0	10	29	7	6	2	13	0	0	2	0	0	0.00	2.35	6.82	1.65	1.41	0.47	3.06	0.00	0.00	0.47	0.00	0.00
West Beach	Private	81	25	7	38	7	8	74	17	0	0	9	0	19.06	5.88	1.65	8.94	1.65	1.88	17.41	4.00	0.00	0.00	2.12	0.00
	Public	0	19	37	15	2	2	34	0	1	3	32	14	0.00	4.47	8.71	3.53	0.47	0.47	8.00	0.00	0.24	0.71	7.53	3.29
West Croydon	Private	117	66	0	35	6	10	68	8	0	0	0	0	27.53	15.53	0.00	8.24	1.41	2.35	16.00	1.88	0.00	0.00	0.00	0.00
	Public	0	31	50	13	13	4	4	0	0	0	0	0	0.00	7.29	11.76	3.06	3.06	0.94	0.94	0.00	0.00	0.00	0.00	0.00

1998		NUMBER OF POINTS PER SUBURB												PERCENT COVER PER SUBURB (%)											
		Impervious			Tree		Plantable Space		Other					Impervious			Tree		Plantable Space		Other				
Suburb	Tenure	ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV	ImpBld	ImpOth	ImpRd	TrPer	TrImp	BG	GrOth	GrSpt	WV	W	B	DV
West Hindmarsh	Private	123	51	0	49	11	7	58	0	0	0	0	0	28.94	12.00	0.00	11.53	2.59	1.65	13.65	0.00	0.00	0.00	0.00	0.00
	Public	0	28	51	13	11	8	12	0	2	1	0	0	0.00	6.59	12.00	3.06	2.59	1.88	2.82	0.00	0.47	0.24	0.00	0.00
West Lakes	Private	87	38	2	27	5	9	37	14	0	0	0	0	20.47	8.94	0.47	6.35	1.18	2.12	8.71	3.29	0.00	0.00	0.00	0.00
	Public	1	18	53	13	4	6	35	0	0	75	1	0	0.24	4.24	12.47	3.06	0.94	1.41	8.24	0.00	0.00	17.65	0.24	0.00
West Lakes Shore	Private	79	37	0	24	7	10	49	2	0	0	0	0	18.59	8.71	0.00	5.65	1.65	2.35	11.53	0.47	0.00	0.00	0.00	0.00
	Public	2	19	38	12	6	1	36	22	0	25	31	25	0.47	4.47	8.94	2.82	1.41	0.24	8.47	5.18	0.00	5.88	7.29	5.88
Woodville	Private	125	69	2	34	12	7	60	0	0	0	0	0	29.41	16.24	0.47	8.00	2.82	1.65	14.12	0.00	0.00	0.00	0.00	0.00
	Public	8	30	48	8	11	2	9	0	0	0	0	0	1.88	7.06	11.29	1.88	2.59	0.47	2.12	0.00	0.00	0.00	0.00	0.00
Woodville North	Private	140	62	2	35	8	16	79	0	0	0	0	0	32.94	14.59	0.47	8.24	1.88	3.76	18.59	0.00	0.00	0.00	0.00	0.00
	Public	2	20	29	9	7	2	8	6	0	0	0	0	0.47	4.71	6.82	2.12	1.65	0.47	1.88	1.41	0.00	0.00	0.00	0.00
Woodville Park	Private	118	67	0	47	10	12	72	0	0	0	0	0	27.76	15.76	0.00	11.06	2.35	2.82	16.94	0.00	0.00	0.00	0.00	0.00
	Public	1	26	31	10	11	0	20	0	0	0	0	0	0.24	6.12	7.29	2.35	2.59	0.00	4.71	0.00	0.00	0.00	0.00	0.00
Woodville South	Private	120	45	3	53	13	10	62	4	0	0	0	0	28.24	10.59	0.71	12.47	3.06	2.35	14.59	0.94	0.00	0.00	0.00	0.00
	Public	0	21	44	10	7	1	15	17	0	0	0	0	0.00	4.94	10.35	2.35	1.65	0.24	3.53	4.00	0.00	0.00	0.00	0.00
Woodville West	Private	101	56	0	38	6	9	97	0	0	0	0	0	23.76	13.18	0.00	8.94	1.41	2.12	22.82	0.00	0.00	0.00	0.00	0.00
	Public	1	21	45	11	13	6	20	1	0	0	0	0	0.24	4.94	10.59	2.59	3.06	1.41	4.71	0.24	0.00	0.00	0.00	0.00